POWER PLANT ENGINEERING

GENERATION - TRANSMISSION - DISTRIBUTION - UTILIZATION

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GARBAGE

Garbage—to you and to us maybe, but not to the chemist, the biologist or the combustion engineer. To them it is a valuable commodity, thought of in terms of B.t.u.'s or as the raw material for the manufacture of astonishing products, confections even. Garbage is finally coming into its own and in many parts of the country plants have been built for converting it either into power or useful products. The latest of these is the new incinerator plant at Providence, R. I., where two 2150 kw. turbo-generators operate from a steam plant which uses garbage as fuel. At this plant, as described on page 107, some 160 tons of garbage are burned every 24 hours. The plant supplies all the electrical energy needed to operate adjacent sewage disposal and sewage pumping plants. The above photograph shows garbage being dumped into the receiving storage hoppers at this plant.

WITH THE EDITORS

The Unified Steam Power Plant

FOR SOME reason a steam plant has never been seriously considered as a unified power plant. Except in the case of the steam locomotive and some of the early "Locomobiles," the steam plant has always been regarded as two separate elements, a steam generating element and a steam utilizing element. This was only natural, perhaps: the technique of steam generation was so entirely different from that of utilizing steam in prime movers that the designers and operators of the respective elements lived in different worlds, so to speak; each remained in his own domain.

There was probably another reason for this separation of the boiler and engine room; the fact that in many instances there were other uses for steam besides its use by engines or turbines. This often resulted in boiler plants and engine or turbine installations of entirely different size in terms of capacity. In the case of the steam locomotive and the steam automobile, where the entire output of the boiler is delivered to the engine, the problem was simplified and in these instances a unified plant resulted.

During the many years of development and use of steam power plants, however, many new ideas have been adopted and new practices evolved. Oil and pulverized fuel, air preheating, superheating, the extraction turbine, the completely water cooled furnace, high steam pressures and temperatures, these and many other developments have come into general use. Also there has been remarkable development in the application of automatic control to all sorts of functions. New materials also have come into use, high temperature alloys, new insulating materials which are more effective, stronger and lighter than older materials.

All these developments make possible, today, a new type of power plant—a plant that is built as a single unit, complete in itself and as self contained as an automobile engine. As a matter of fact, several plants of this kind have already been built and are in use, and others are under construction. Produced by the combined efforts and resources of several of the leading manufacturers of power plant equipment, these new units are compact, high pressure steam power plants, fully automatic in response to changes in demand. One unit now in service has an output of 21,000 lb. of steam per hr. at a pressure of 1500 lb. per sq. in. Intended capacities of other units will be such that they will furnish steam for power plants of 2000 to 10,000 hp. In a particular instance a completely coordinated power generating plant incorporating the steam producing unit and turbo-genertor is being installed in a small, isolated plant of a large industrial concern to supply electric power and low pressure steam for building heating.

The significance of this step in power plant engineering cannot be too fully emphasized, for it marks the beginning of a new era in steam power plant construction and perhaps the end of the steam power plant as we know it today.

Why? Because it is logical. Because it is the way a power plant should be built and operated. Because it is in line with modern progress and because it is a vast improvement over the cumbersome uncoördinated power plants of today. There can be no question but that this form of completely factory built steam power plant is going to become popular.

How large units of this kind can be built, only time will tell, but 10,000 hp. is not small as plants go and this capacity seems assured, even now. The chances are that in larger capacities this type of plant would lose some of its advantages and that its greatest possibilities lie in the region up to 10,000 hp.

Surface Condensers

RESEARCH and practical development has of recent years improved surface condenser efficiency greatly. At the same time intensive application of higher pressures and temperatures and the extraction cycle has reduced the percentage of heat reaching the condenser. The combined result has been a drastic reduction of surface per kilowatt of generating capacity and a tendency to consider this ratio as a factor in plant design without considering the condenser and its performance on its own merits as a major piece of plant equipment.

Condensers are a major factor in providing the pure feeding water necessary for high pressure boilers and, by reducing the back pressure, increasing the cycle efficiency. This higher efficiency means reduced fuel charges and decreased boiler capacity both of which should be credited to the condenser.

It is an odd fact that the total cost of producing a vacuum of about 3 to 6 in. is little more than the cost of condensing steam at atmospheric pressure for feedwater purposes. Beyond this the cost increases, slowly at first and then more rapidly to infinity as the theoretical vacuum set by the available water temperature is approached.

Evaluation studies are not, however, exact. They depend upon basic assumptions which are often made without sufficient data or as justification of an arbitrary ratio selected to meet certain cost limits. The calculated sizes may vary as much as 50 per cent, the smaller surface severely handicapping plant performance in years to come because undersized condensers are unduly sensitive to tube fouling. Many of the factors involved are difficult or impossible to evaluate properly but the influence of the major ones and the case of more generous sizing is presented in the article, "What Condenser Surface?" a survey of years' experience in surface condensers and the result of tedious hours of calculation on innumerable jobs. The labor involved will not be apparent to the readers but the points brought out deserve serious consideration.

Design Features of the LONDON AND MARMET Hydro Developments

By

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Vice President and Chief Engineer
American Gas & Electric Co.

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Transmission Engineer
American Gas & Elec. Co.

TWO LOW HEAD, automatic, hydroelectric plants located on the Kanawha River near Charleston, W. Va., have recently been placed in operation by the Kanawha Valley Power Co., a subsidiary of the American Gas and Electric Company. One of these plants is located at Marmet, and the other at London, the former being 68 mi. and the latter 83 mi. from the mouth of the river.

Formed by the junction of the New and Gauley Rivers in southwestern West Virginia, the Kanawha River flows in a northwesterly direction to the Ohio River at Point Pleasant, W. Va., a distance of 97 mi. It has a total water-shed area of 12,300 sq. mi. At London the drainage area is 8,485 sq. mi. with an average flow of 13,150 sec. ft., while at Marmet the drainage area is 8,810 sq. mi. and the average flow 13,520 sec. ft. Minimum flows of about 1,000 sec. ft. have been recorded, while during high floods the flow has exceeded 200,000 sec. ft.

The Kanawha River is a navigable stream with improvements in the interest of navigation dating as far back as 1875. At that time provisions were made for a 6 ft. navigable depth from the Ohio River to a point about 90 mi. above the mouth of the river by the installation of eight locks with movable dams and two locks with fixed dams. This construction was completed in 1898. No change in this fundamental scheme of navigation improvement was made until the passage of the River and Harbor Act of 1930, which authorized the replacement of the four upper locks and dams by two of higher lift so as to increase the depth

Fig. 1. Marmet is located 68 mi. from the mouth of the Kanawha River and has one fixed, one Kaplan and one automatically adjustable blade runner, the three totaling 21,450 hp. Many new ideas and developments are incorporated in this and the London plant 15 mi. upstream.

Fig. 2. London, like Marmet, shown by Fig. 1, is built at a Government navigation dam under a 50 yr. license from the Federal Power Commission. Two fixed blade and one Kaplan wheel totaling 20,450 hp. are installed. The normal load of both plants is 23 ft.

of the channel to 9 ft. These two new structures are located at Marmet and London, and the hydro developments described here are located at these new dams.

Characterized at the Third World Power Conference as an outstanding example of "cooperative construction by state and private capital," these two plants will warrant the attention of all interested in water power development.

Designed as a component part of dams previously built by the government for navigation, extreme care was necessary to bring the cost of power down to below that of equivalent steam station output. The resulting design is a simple layout, built by a small construction organization with a minimum of unproductive refinement. Everything had to pay its way—the design is essentially functional.

The dominating idea was to utilize the most practical engineering ideas and developments, regardless of whether they were old or modern, tested or new as long as they were fundamentally sound. Many of these ideas had been discussed and were in the course of development for years, others were developed by local conditions. It is extremely fortunate for the engineering profession that opportunity knocked at the door of an organization with the courage to act.
Editor's Note

Dams and adjacent navigation locks were installed by the United States War Department. These have been described elsewhere,[1] so that no detailed description of them will be given here. It may be of interest, however, to note that the dams are of the roller gate type, each dam containing five rollers each slightly in excess of 100 ft. in length with a height including the longitudinal aprons of 26 ft.

Under the authority of an Act of Congress approved June 10, 1920, the Federal Power Commission was authorized to issue licenses for the purpose of constructing and operating power projects in connection with dams constructed for the improvement of navigation. In January of 1934, the Kanawha Valley Power Company was granted a license to construct power stations at Marmet and London and to operate the same for a period of 50 yr. on a yearly rental basis.

[1]Engineering News Record, Vol. III, No. 12.

Basis of Development

In undertaking the development of the hydro-electric possibilities at these two dams those responsible for the decision to proceed had definitely in mind, and were influenced, first, by the fact that the dams as built had definite provision for power development; and second, by the fact that since the two sites were located in the heart of the Charleston Division of the Appalachian Electric Power Co., it was natural that the most economical absorption of the power available could be accomplished by a development in which the outputs were tied into that system. Still, in making the decision to proceed, they were not unmindful of the possibility that unless extreme care was exercised in the planning and construction of the two developments the cost of the power would exceed that obtainable from equivalent steam generating stations.

This needs to be kept in mind in any analysis of, or justification for, the fundamental basis of the design chosen. In essence, this reduced itself to a determination to keep everything down to the simplest arrangement; a simple layout, a small construction organization and a minimum of unproductive refinement. Very little was included that could not definitely pay its way. It was only by following this criterion that the cost of the power developed was brought into the competitive zone of steam generated power.

General Layout

Power plant structures at both developments are located at the westerly ends of the United States Government dams. Both power house buildings are essentially the same, being 150 ft. long and 55 ft. wide, housing three turbines spaced 50 ft. on centers. The principal difference between the two plants is in the location of the storage structures for the emergency bulkheads of the dam and the type of bank retaining construction at the landward end of the buildings. One of the license provisions was that the power com-

pany should provide for the storage of emergency bulkheads used by the Government when work is performed on the gates of the dam. The bulkhead consists of seven sections, each 104 ft. long and 4 ft. high and weighing some 28 t. At Marmet these are permanently stored on the landward end of the structure. From there, they are picked up by means of a traveling crane which carries them along a crane runway, erected over the storage space and along the intake piers, past the power house to the proper gate opening of the dam. This is shown clearly in the general location plan, Fig. 3, which shows also the plan of the generator floor, the forebay and tail-race structures, grading, and the permanent cellular sheet steel pile retaining structure landwardly of the plant. Figure 1 is an aerial view taken at Marmet, which shows not only the dam and power house structures, but gives an excellent view of the compact electrical yard in front of the plant.

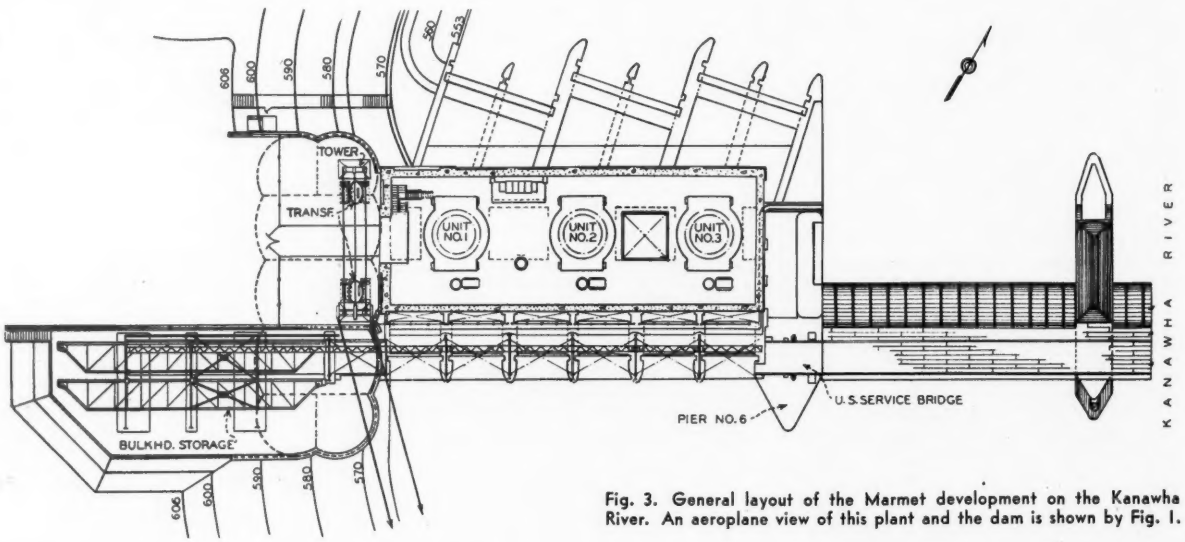


Fig. 3. General layout of the Marmet development on the Kanawha River. An aeroplane view of this plant and the dam is shown by Fig. 1.

At London, where property restrictions due to the proximity of a railroad prevented the storage of bulkheads on the ground at the landward end of the plant, a bridge and platform were constructed over the forebay for this purpose. This is shown in the aerial photograph, Fig. 2, which shows also the dam and the lock structures on the north side of the river.

Construction Plan and Materials

The general construction plan followed at both plants is briefly as follows:

Initial construction work involved the removal of riprap which had been placed by the Government on the excavated slopes downstream from the dam; also earth excavation at the higher levels. A cellular coffer-dam consisting of interlocking steel sheet piling was next constructed extending from the abutment pier of the dam to the bank so as to enclose the downstream side of the power house area. The Government, as a part of the dam construction, had built a cellular sheet piling coffer-dam tying the upstream end of this abutment pier to the bank upstream from the power house. Power shovel digging then proceeded in the power house area, supplemented by drag-line bucket and clam-shell excavation in the deeper areas. This was followed by rock excavation and some placing of riprap on the finished slopes. The excavate was hauled in trucks and tractor trailers to areas adjacent to the power station site where it was used for grading and to fill gulleys and depressions in the land. Earth excavation was made in the dry tail-race area downstream from the lower coffer-dam, followed by sub-aqueous excavation of the remaining earth and rock in this area.

At Marmet a standard one-yard mixing plant was erected in the forebay area adjacent to the coffer-dam, concrete being transported from the mixer to the forms by means of derricks and bucket buggies. At London a one-yard plant and "Pumperete" machine with remixer were installed, the latter being installed with the definite idea of obtaining comparative performance under two substantially similar sets of conditions.

Particular care was taken on both jobs to obtain concrete that would be very dense and free from cracks and which would withstand freezing and thawing. It should be noted in this connection that the locality in which the plants are erected is subject to frequent cycles of freezing and thawing and is more severe in this respect than areas considerably further north or further south. For this reason special attention was given to the specifications for the cement, the type of aggregates and the mix. The standard A. S. T. M. specifications for cement were modified so as to reduce the heat of hydration and thereby the tendency for the development of cracks during cooling. The cement for the portions of the structure subject to freezing and thawing and for the superstructure were purchased under specifications limiting the tri-calcium silicate compound to 50 per cent of the cement by weight, and the tri-calcium aluminate to 12 per cent. The tensile strength of mortar at 7 da. as determined by standard tests with standard sand was limited to a range of 225 to 275 lb. per sq. in.

Two classes of concrete were used and designated as Class A and Class B, respectively. Class A concrete, containing 550 lb. of cement per cubic yard,

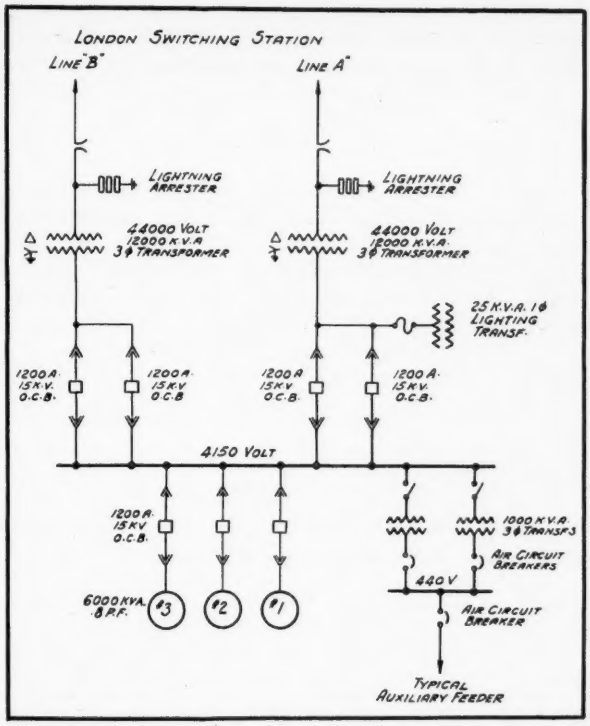


Fig. 4. Simplified electrical layout. This is the same for both plants, identical electrical units being used for all six turbines. A single bus was employed, each generator being switched by a single modified truck type low tension breaker.

was used on the portions of the structure exposed to freezing and thawing, and on other portions in which water-tightness was an essential item. It was also used on sections with heavy reinforcement and in all of the thin wall sections. Class B concrete, containing 440 lb. of cement per cubic yard, was used for the larger masses of concrete not subject to the above severe conditions. In addition hydraulic lime was used as an admixture in both classes of concrete to the amount of 60 lb. per cubic yard of concrete.

Proportioning of the aggregates was determined by the supervising engineer on the job so as to obtain a workable mix with a minimum of water. The total water content per bag of cement in no case exceeded 6 gal. including free moisture contained in the aggregate. The slump of the mix varied from 1½ to 3½ in.

All concrete was deposited wherever possible in horizontal layers not exceeding 18 in. in thickness, the pouring being carried on as a continuous process. Height of lifts or pours did not exceed 18 ft. and during hot weather the maximum height was reduced to 8 ft.

All concrete was subjected to vibration supplemented by hand spading adjacent to the forms on exposed faces. Special precautions were taken to prevent any inferior material in the finished concrete at the top of a lift or near the face thereof. A thin layer of concrete was removed at the top of every lift and disposed of as waste material. All concrete surfaces were cured for a period of 14 da. by continuous spraying.

Hydraulic Plant and Equipment

Hydraulic and physical conditions at the two plants were such that it was possible to design practically duplicate installations. Studies indicated that the most economical combination of units at each plant would consist of three units of the vertical shaft propeller type, two to have fixed blade runners and one an adjustable blade runner. The turbines for London were purchased on this basis but for Marmet an automatically-adjustable propeller of a new type was substituted for one of the fixed-blade propellers. A short description of this runner will be given later in this article.

Fixed-blade runner turbines have a rated capacity of 6600 hp. under a net effective head of 23 ft. at a

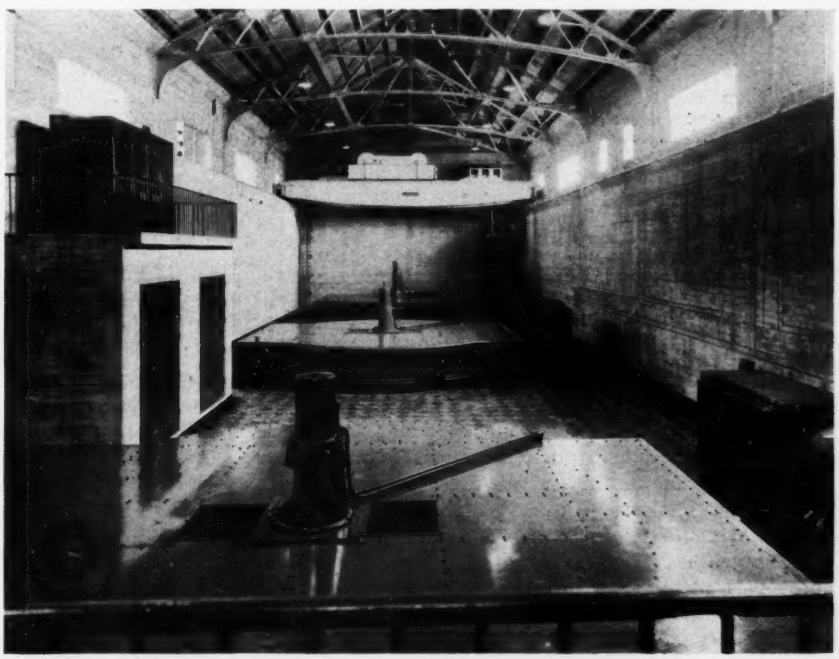


Fig. 5. Many unusual features are incorporated in the design. This is the interior of Marmet. An outstanding feature of the design is the low headroom made possible by the umbrella type generators, special cranes and omission of direct connected generators. The plants are automatically operated. They are heated by bleeding the generator ducts, glass bricks allow daylight illumination and eliminate windows, and ventilation is provided by three reversible fans. Note the cabinet type governors at the right of the units, one of the first installations of this type to be made.

speed of 90 r.p.m. The diameter of the runner is 177 in. The automatically-adjustable-blade runner unit for Marmet has the same general dimensions as the fixed-blade unit, but the rated capacity is 7600 hp. The adjustable-blade, Kaplan-type units, have a rated capacity of 7250 hp. under a 23 ft. net head at a speed of 90 r.p.m. The diameter of the runner is 169 in.

The fixed-blade runner turbines and the automatically-adjustable-blade turbine employ integral, cast-steel speed rings while the Kaplan-type units have separate stay-vanes, the lower ends of which are provided with feet and foundation bolts for embedding in the concrete just outside of the throat-ring. As a matter of record it may be noted that the erection of the separate stay-vanes proved much more difficult than that of the integrally cast speed-ring due to the difficulty of setting the vanes to the exact elevation required in order to secure a proper fit with the curb-ring.

Main turbine bearings on the fixed-blade and automatically-adjustable-blade turbines are of the adjustable lignum vitae type lubricated by water from the turbine casing. The bearings on the Kaplan units are of the Cutless rubber type also lubricated by water from the turbine casing. The water supply for both types of bearings passes first through a coarse strainer at the inlet and later through a fine strainer located in the turbine pit. Due to dredging in the stream above both plants and due to the extremely sharp sand which was stirred up by the dredging operation, some wear has occurred in the bearings. Frequent cleaning of the strainers has also been necessary. In view of this, and because the plants are definitely set up for full automatic operation, it has been decided to install continuous filter systems in the water-supply for both stations.

Electric Plant and Equipment

The electrical layout of the plants is indicated in the one line diagram, Fig. 4. This is the same for both plants. Although there exists a difference in hydraulic output of the three machines in each plant, it will be observed that it was possible to use identical electrical units for all generators at both plants. This gave not only complete interchangeability but offered other obvious economies as well.

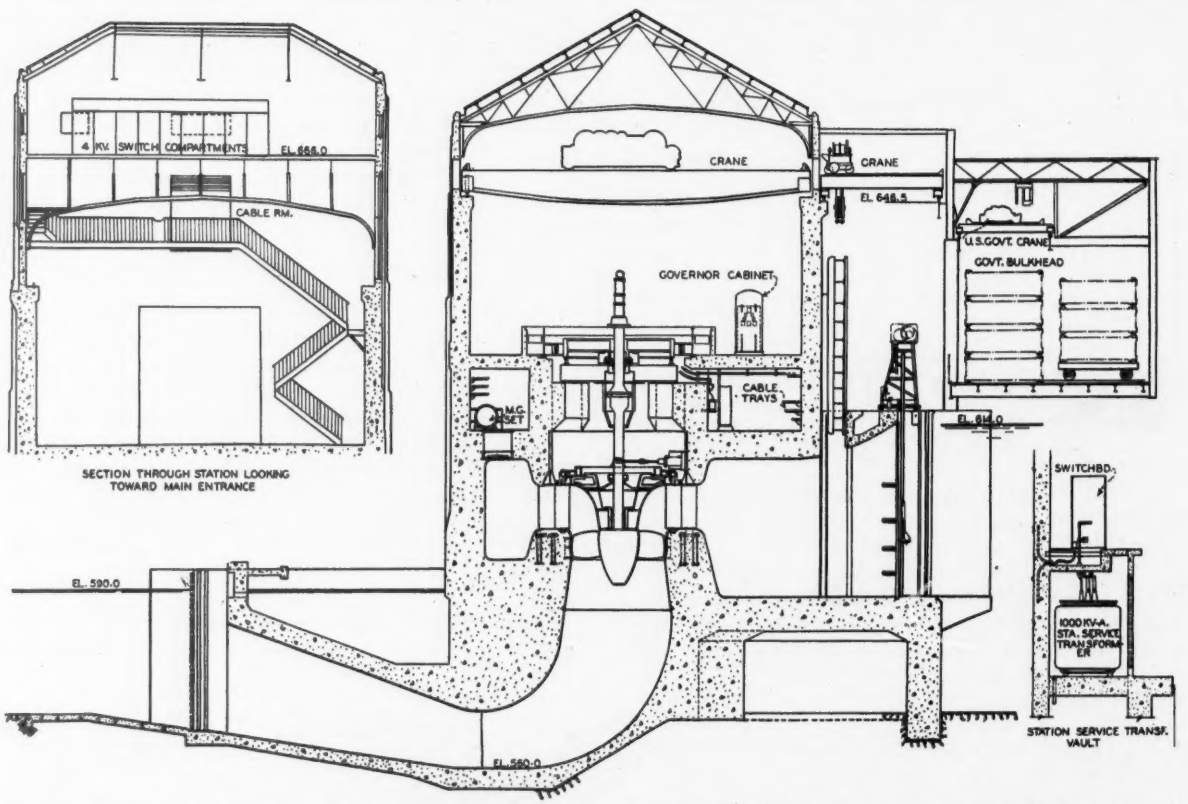


Fig. 6. Cross section through the London plant showing the Kaplan turbine. Three units operating under a head of 23 ft. are installed. The two fixed blade runners are rated at 6,600 hp. each, the Kaplan runner at 7,250 hp. An aeroplane view of this plant is shown by Fig. 2.

All six generators in the two plants are therefore identical. They are rated at 6000 kv-a., 90 r.p.m., 80 pole, 3 ph., 60 cycle, 4,510 v. They are designed for a WR^2 of 5,000,000 and a runway speed of 190 r.p.m. The thrust bearings are of the General Electric self-lubricated type consisting of a cast-iron rotating plate and a babbitted stationary plate resting on precompressed springs so that the load will be distributed over the entire bearing surface. Guide bearings, of the cylindrical seat, babbitt-lined, sleeve-type, are located below the thrust bearings.

Selection of umbrella-type generators, a proper proportioning of lengths of shafts between turbine and alternator, a special crane arrangement, and the omission of direct-connected exciters, all contributed to a minimum height of superstructure, which is outstand-

ing in the design. This is seen very clearly from an examination of Fig. 6, which shows a section through the Kaplan-unit at London. The omission of the direct-connected exciters made possible considerable additional savings by permitting the obtaining of excitation at 1200 r.p.m. instead of at the 90 r.p.m. of the main machines.

Examining Fig. 4, it will be seen that but a single bus was employed, each generator being switched by a single modified truck type low-tension breaker. Two 3-phase transformer banks take the plant output and deliver it through two 44 kv. transmission lines, a line to a transformer; and these lines tie into 44 kv. switching points of the Appalachian Electric Power Co. in the vicinity of the dam. The actual distance of these points from the respective stations is 0.45 mi. at London and 0.77 mi. at Marmet.

It will be observed that the low side of the main banks uses two switches in parallel, that arrangement being actually more economical than one single low-voltage breaker of double the rating. Furthermore, the adoption of the two-transformer arrangement has resulted in the total elimination of the high tension switch and in the substantial elimination of the high-tension yard. This is shown in Fig. 8, which is a front view of the Marmet plant, showing the two 12,000 kv-a. transformer banks and the two outgoing lines.

The auxiliary bus arrangement is perhaps a trifle more elaborate than the general design scheme would warrant, but as regards sources of feed in particular, it needs to be borne in mind that the plant is under obligation to furnish continuous operating power for the dam and lock structures. Hence, that part of the job was somewhat reinforced. Except for this, the lay-out is extremely simple.

Special Features

London and Marmet plants combine, in the design, many new developments and ideas pertinent to hydro-electric power plants in general and to plants of intermediate size in particular. Many of these ideas had been discussed and were in the course of development for years preceding the construction of London and

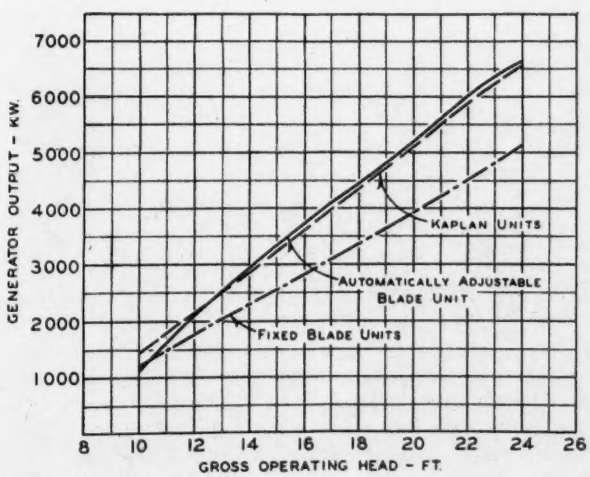


Fig. 7. Average performance curves of the three types of wheels installed in the two plants. The fixed blade units are rated at 6,600 hp., the Kaplans at 7,250 hp. and the automatically adjustable unit at 7,600 hp.

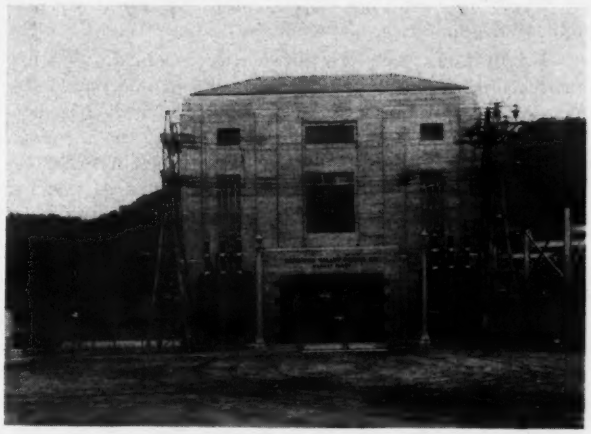


Fig. 8. Front view of the Marmet plant showing the two 12,000 kv-a. transformer banks and the two outgoing lines. This is a closeup of the right end of the plant as shown in Fig. 1.

Marmet, but were first carried out there. A short description of some of these particular features may be of interest.

Newport News Adjustable Unit. The Newport News automatically-adjustable-type runner used at Marmet is a new type in that no interconnection is provided between the runner vanes and the governor. A short description of this has previously appeared elsewhere.[2] The runner consists of four vanes with integrally-cast stems supported on roller bearings, two of which are radial and one a thrust bearing. The four vanes are interconnected by a rack and pinion to a piston located in the upper part of the hub. The vanes are freely pivoted and so arranged that water impinging on the vanes sets up a moment, tending at all times to open or increase the pitch of the vanes.

This tendency to open, however, is balanced by two reactive devices, the principal one consisting of the piston previously described, which is urged downward by the differential in pressure between head-water and draft-tube. Head-water pressure is admitted to the top of the piston from the scroll-case and draft-tube pressure is admitted to the bottom through ports in the piston stem. An auxiliary or adjustable reactive device consists of a heavy duty spring located in the hollow turbine shaft and acting downward on the piston. Movement of the runner vanes to correspond with changing load or variations in head is entirely automatic and is controlled by the reactive devices.

Performance

Performance of the unit has to date been highly satisfactory. Figure 7 shows the actual performance of the unit under various heads and compares the output with that of the fixed-blade units which are almost identical with the adjustable-blade unit except for the adjustable feature. Figure 7 also shows the actual output of the Kaplan units. It should be noted, however, that the rated capacity of the Kaplan unit is 7,250 hp., while that of the automatically-adjustable-blade unit is 7,600 hp. and the fixed-blade unit 6,600 hp. The diameter of the automatically-adjustable and fixed-blade runners is 177 in., while that of the Kaplan runner is 169 in. The performance of all three types

[2]Power Plant Engineering, Vol. XXXIX, No. 8.

of units has been in excess of the guaranteed and expected capacities.

FIRE PROTECTION. An automatic carbon dioxide fire protection system is provided for the protection of the generators, control room, cable rooms, cable connecting duct, cable terminal room, and transformer rooms. Thirty 50 lb. cylinders are grouped together and arranged so as to release the proper amount of gas for the spaces to be protected, depending upon the location of the fire and the volume of the room to be protected.

HEATING. The buildings are heated by means of bleed heat from the generators. The hot air passes out

DESIGN, CONSTRUCTION AND EQUIPMENT DATA

Engineers and Supervisors	American Gas & Elec. Co.
Consulting Engineer	P. W. Scheidenhelm
Consulting Architect	Eddy Fairchild
General Contractors	Boso & Richie
Hydraulic Turbines	Baldwin-Southwark Corp. (I. P. Morris Div.) (2) Newport News Shipbuilding & Dry Dock Co. (4)
Governors	Woodward Governor Co.
Alternators	General Electric Co.
Exciters	Westinghouse Elec. & Mfg. Co.
Transformers	Westinghouse Elec. & Mfg. Co.
Auxiliary Switches	Delta Star Electric Co. Westinghouse Elec. & Mfg. Co.
Automatic Equipment and Supervisory Control	Westinghouse Elec. & Mfg. Co.
Batteries	Electric Storage Battery Co.
Fire Protection	C-O-Two Fire Eq. Co. Walter Kidde & Co.
Cranes	Phillips & Davies, Inc.
Gates	Virginia Bridge & Iron Co.
Gate Hoists	Phillips & Davies, Inc.
Stop Logs	M. H. Treadwell Co., Inc.
Trash Racks	Phillips & Davies, Inc.
Rack Rakes and Hoists	Newport News Shipbuilding & Dry Dock Co.
Structural Steel	Virginia Bridge & Iron Co.
Reinforcing Steel for Concrete	West Virginia Rail Co. Concrete Steel Co.
Ventilating Equipment	Buffalo Forge Co. Minneapolis-Honeywell Co.
Concrete Roof, Ceiling and Floor Slabs	Federal American Cement Tile Co.
Roof Tile	W. P. Shawver Sons Co., Inc.
Asphalt Tile Floor	David E. Kennedy, Inc.
Cement	Alpha Portland Cement Co. Green Bag Cement Co. of W. Va. Pennsylvania-Dixie Cement Corp.
Hydraulic Lime	Riverton Lime Co.
Winter-Kennedy Piezometers	Simplex Valve & Meter Co.

from the generator housing through two sets of louvres located at opposite points of the housing. Circulation of the air throughout the building is expedited by means of three suction fans of 12,000 c.f.m. capacity located near the elevation of the bottom of the roof truss; two fans being located near the river end of the building and one near the landward end. The heating in the second story control room is augmented by means of two 20-w. electric heaters.

For ventilating the buildings during the summer months, the louvres in the generator are closed and the direction of rotation of the ventilating fans near the roofs is reversed so that outside air is admitted to the fans through ducts leading to louvres placed in the side walls of the buildings.

GOVERNORS. These plants contain one of the first installations of a new type of Woodward governor known as the "cabinet" type in which the actuator, pumping unit, sump tank, piping and restoring mechanism are consolidated into one compact unit. The governing mechanism and oil pumping units are mounted on a fabricated steel sump base as an integral part thereof, and the whole assembly is enclosed in a neat cabinet. The actuator cabinets for the Kaplan units include pilot valves for the operation of the Kaplan servomotors. A panel is attached to the front of each cabinet equipped with gauges showing oil pressures, gate position, and the setting of a gate-limit device, together with various control switches.

Three hundred pounds pressure is provided to operate the turbine servomotors and the Kaplan servomotors. Originally it was intended that the pressure-tank pumps should pump the necessary air which must be replenished from time to time in the pressure tanks. It was found, however, that at this pressure the pumps when pumping air were very noisy, and it was feared that serious wear of the gears might be the result. For this reason compressors were installed at the plants which could be attached to the pressure tanks so that when it became necessary to replenish air lost in operation, the pumps would be relieved of the necessity of doing this work.

CONTROL AND RELAYING. The two stations have been designed and laid out for full automatic operation. Due, however, to the necessity of the most complete coordination between the operation of the plants and the river flow from the standpoint of navigation requirements, supervisory control has been superimposed upon the automatic equipment. This makes possible a parallel control from the Cabin Creek steam plant whenever the navigation-pool level requires particularly close control. For this purpose there have been provided on the supervisory system the following indications and control features:

A. Meter Indications
   a. Headwater level.
   b. Tailwater level.
   c. Kw. indication for each generator.
   d. Kv-a. indication for each generator.
   e. Bus voltage.
   f. Gate position indication for each generator.

B. Control and Operating Indications
   a. Setting up the automatic sequence to start, bring up to speed, and synchronize all three generators at each plant to the bus, together with stopping facilities and indication of the position of the main generator oil circuit breaker.
   b. Complete control of the load of each unit by operation of the governor. This is accomplished by simultaneous indication of the load on the kw. meter.
   c. Changing the operation of a unit from generator to synchronous condenser and vice versa, together with an indication as to prevailing operation.
   d. Control of bus voltage and station reactive by means of voltage regulator adjustment for each generator.
   e. Closing and tripping of oil circuit breakers on the 440 v. side of the station auxiliary transformers, together with light indication of the position of these breakers.
   f. Starting the automatic sequence to close and trip the two 4 kv. main transformer oil circuit breakers at each plant, together with the obtaining of an indication of their position.
   g. Starting the automatic sequence to close and trip the Government lock feeders, together with light indication as to the position of the automatic relays.

In addition to the above, a scheme of metering has been installed so that the Cabin Creek operator may check from hour to hour the total output of the plants, together with the output of each individual unit. All of the above listed controls and indications are also provided at the plants themselves. Neither the design nor the plan of operation, however, call for operators to be stationed at the plants beyond the period of initial operation to iron out the usually encountered minor operating and design difficulties. After this initial period, all operating men will be withdrawn from the plants. A daily inspection will, however, be made for general maintenance and cleaning purposes.

In order to relieve the operator at Cabin Creek of the constant supervision required in maintaining accurate pool levels at the two plants, there is being added

complete float-control. This scheme of operation will permit the automatic loading of the units in response to the rise and fall of the pool level. This will, however, at no time affect independent control by the Cabin Creek operator by means of the supervisory system.

The automatic equipment provided for the generators, which makes supervisory operation from Cabin Creek possible, performs the following functions in the sequence given:

a. Starts the motor generator set supplying excitation to the units.
b. Energizes the governor solenoid, allowing the gates of the turbine to open slowly.
c. Connects the field to generator at near synchronous speed at a certain reduced value which, under the operation of the regulator, slowly builds up to the normal no-load value.
d. Adjusts the speed of the unit by operation of the governor to synchronize definitely with the bus.
e. At the proper point, so that the oil circuit breaker may be closed in exact synchronism, the unit is synchronized to the bus and the breaker is closed by means of the automatic synchronizer.
f. The unit is automatically loaded to its upper limit.
g. From now on the load on the unit is under complete control of the operator at Cabin Creek. He in turn may exercise that control or he may turn it over to the automatic pool control system.

Automatic control as applied to the two incoming transformer circuits at each plant operates to close the oil circuit breakers under the following conditions:

a. Without synchronizing if the incoming line is energized and the bus is de-energized.
b. With check synchronizing or automatic synchronizing if both the incoming line and the 4 kv. bus are energized.

Each generator is protected against:

a. Overspeed.
b. Bearing failure either of generator or exciter.
c. Overheating of machine windings.
d. Overvoltage.
e. Undervoltage.
f. Field failure when operating as a generator.
g. Any failure detectable by differential protection.
h. Overload on the motor-generator exciter.
i. Failure of oil pressure.
j. Failure of water supply to guide bearings.
k. Fire in the generator itself, as determined by the tripping of the CO_2 fire-fighting equipment for the particular generator in trouble.

Protective relaying equipment for the incoming 44 kv. lines is of the conventional balanced reverse power type.

Control rooms at each of the hydro plants house not only the control, automatic and supervisory boards, but also the low tension switch-gear and the battery. The arrangement for Marmet as shown in Fig. 9 is duplicated at London. As will be seen, this arrangement is not only compact but not at all unattractive. The control room at each plant is located in the front or landward side of the building at an elevation of 42 ft. above the generator floor. This location places the equipment well above the maximum flood level and also in close proximity to the transformer banks which are located directly in front of the building.

Fig. 9. Marmet control room with automatic and supervisory boards, low tension switchgear and battery. This is located at the front side of the plant at elevation 42 above the generator floor, safe from floods and close to the transformer bank located directly in front of the building.

Architecture

A single term can be used to describe the architecture of the London and Marmet plants and that is "functional." The volume of the buildings was reduced to the absolute minimum. The arrangement of the equipment and the enclosure was determined solely by the technical functions of the various parts. A minimum of ornamentation, amounting to almost a total lack of decoration, was used. The heating and ventilating were coördinated with, and really obtained as a by-product of, the operation of the alternators. The adoption of this scheme made possible the elimination of the conventional windows. Daylight illumination, however, was obtained by the use of glass brick. With all of this a pleasing effect has been obtained and one which is consistent with the function of the buildings as hydro-electric generating stations. This may be seen from an examination of Figs. 5 and 8, which show, respectively, front elevation and the interior of the building at Marmet. The thought of a power plant stripped down for action suggests itself. This, however, is only following through in the architecture the dominating idea in the whole design, namely: to utilize the most practical engineering idea or development, regardless of whether it was old or modern, tested or new, so long as it was sound; and to produce the power in the most economical and safest manner.

Snow Complications

By John E. Hyler

In many industries and factories, the occasional heavy snowfall causes considerable trouble in one way and another. Not infrequently, traffic must travel over outside tracks, roads and platforms, so that snow removal from such traffic lanes and areas is essential.

Mechanical removal and removal by means of heat in some form are the two outstanding remedies. Many use some form of snow plow which will fasten to the front end of a truck or tractor for clearing areas of considerable scope where it may be necessary. An interesting alternative which is sometimes used to advantage when snow must be hauled away, is to run over it with a power roller, if it chances that one is available. This packs down the snow into a form which allows its easy removal in large chunks, and it is evident that much more can be hauled away in a truck body of given size.

One manner in which heat is used to very great advantage is in the case of electrical snow melters which may be installed at railway switches, to keep them free from ice and snow. An interesting variant is the use of a steam hose to melt snow. If you find a huge drift at the door or in some corner where the snow plow cannot get at it, get busy with the steam hose, if you can find one to reach, and you will soon see the trouble dissolve.

The AUTOMATIC DIESEL PLANT— Is It Practical?

Flexible and simplified Tecomatic control combined with high speed Diesel opens up new field. Three typical installations already in service, combined steam and Diesel, Diesel electric and Diesel pumping plant, demonstrate industrial possibilities.

By George B. Bailey

Thermal Engineering Co.
Boston, Mass.

NEW ENGLAND has a reputation for being conservative but at least three unique Diesel installations made there recently would indicate that this conservatism is well seasoned with Yankee shrewdness and the ability to appreciate worthwhile developments. The automatic, high speed, standardized Diesel engine power plants at the North Easton Municipal Pumping Station, H. Schindler & Co., Inc., Canton, and the Maclan Hat Co., Inc., East Brookfield, all in Massachusetts, show how, with intelligent application, this type of engine can be used to advantage in reducing power costs.

Pumping Station

The Water Commissioners of the Town of North Easton installed a fully automatic Diesel water pumping unit to replace their condemned steam unit. The installation (Fig. 1) consists of a 6 cyl. 4⅜ by 5¼ in. Hercules Diesel engine direct connected to an Aldrich centrifugal pump, all mounted on a common base, and with a capacity of 600 g.p.m. against a 175 ft. head when operating at 1400 r.p.m. The engine is equipped with an electric starter and control, starting and stopping automatically on a decrease or increase of the water level in the standpipe. This pumping station does not have continuous attendance and automatic control was imperative if the Diesel unit were to be operated instead of their electric driven pump. In this case it was also desirable to heat the station with the cooling water from the cylinder jackets and automatic control was included to prevent the room from going below a predetermined temperature.

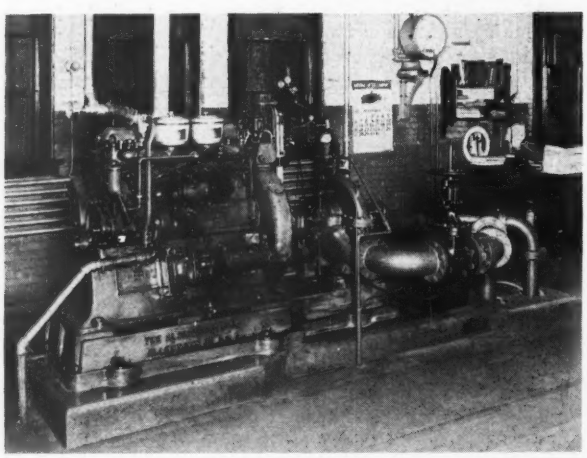


Fig. 1. Automatic Diesel pumping unit at Municipal Pumping Station, North Easton, Mass., which operates to maintain the standpipe level within definite limits

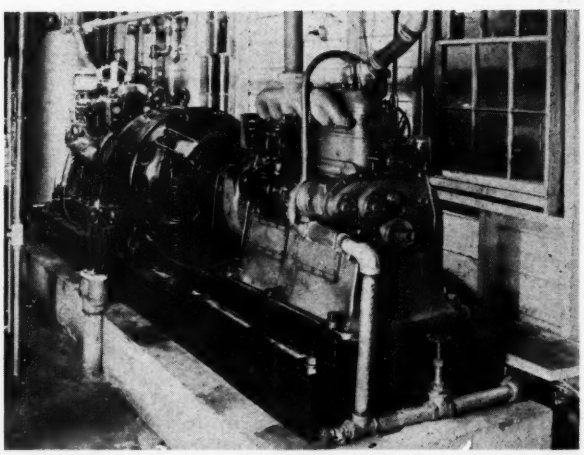


Fig. 2. Automatic Diesel electric generating plant at H. Schindler & Co., Inc., Canton, Mass. This consists of two 40 hp. engines driving a single generator

Since the Diesel pumping unit was put into operation December 7, 1935, it has operated over 1800 hr.,

starting and stopping some six to eight times daily. There has been practically no expense for maintenance. With fuel at 5½ ct. per gal., the Diesel unit was found to operate at a cost equivalent to electric power of less than 0.5 ct. per kw.-hr., as compared to purchased electric power which had averaged 2.8 ct. per kw-hr. The electric pump, which was only ten years old, has, therefore, stood by in favor of the Diesel unit and is now being replaced with another Diesel driven unit.

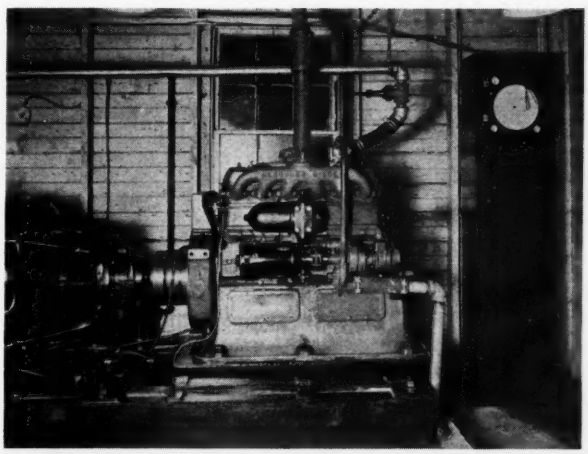


Fig. 3. Side-view of one of the engines from Fig. 2, showing the automatic control cabinet and the over-running clutch which enables either one or both engines to carry the load

Results obtained at the North Easton Pumping Station have shown that this type of engine is entirely dependable, has the necessary stamina for continuous operation with a minimum of attention and maintenance, and, because these small units can be electrically started, lends itself readily to automatic control. Because of the limited horsepower capacity, it only remained to develop a simple method of successfully operating a multiplicity of these engines in parallel in order to enlarge the scope of application beyond that of comparatively small power plants.

Diesel Electric

That such a method is feasible is illustrated by the electric generating plant installed by the H. Schindler & Co., Inc., Canton, Mass., manufacturers of tennis racket strings, fishing tackle, etc. Purchased electric power was a considerable item of their production cost and they decided to cut this cost by making their own power. Because of excessive standby charges it was necessary to eliminate the utility altogether, but, as standby protection was imperative, a multiple unit 50 kw. plant, as shown by Figs. 2 and 3, was decided upon.

This consists of a double-ended, 1200 r.p.m., 220 v., 3 ph., 60 cycle generator driven by two 40 hp., 6 cyl., 3¾ by 4½ Hercules Diesel Engines through over-running clutch couplings which allows either or both engines to drive. Automatic control as installed digresses entirely from precedent, as no attempt is made to balance the load between the two engines. Rather, it provides for the continuous operation of one engine, with the second engine starting and stopping upon an increase or decrease in the load above or below the capacity of the continuous running engine. This plant requires no attendance other than one daily inspection, has functioned perfectly and shows a decided increase in efficiency over a single engine plant.

Charts, Fig. 5, of this installation show the method of loading. Up to a predetermined load one engine carries the load, with the second unit stopped. Beyond this point the first engine operates base load with the second taking the load swings.

The automatic control used embodies standard instruments, of which the dual type exhaust temperature recorder controller is most important. The exhaust temperature of a Diesel engine is an indication of the load it is carrying and this is used for control purposes. The exhaust temperature as recorded on the chart of the controller gives a valuable daily log of each engine operation.

Combined Steam and Diesel

The Anderson-Nichols Associates, Inc., proved themselves engineers not entirely governed by precedent in choosing a multiple, standardized Diesel electric generating unit to supplement the steam engine driven generating unit for the new plant of the Maclan Hat Co., Inc., East Brookfield, Mass. They knew from past experience that a 200 kw. generator driven by a steam engine operating at 125 lb. pressure and 15 lb. back pressure would take care of peak demands for both power and process steam. They also determined that 75 to 100 kw. would be required for standby and to take care of the load during periods when it was not convenient to operate the steam engine. They decided, therefore, to install the 90 kw., 100 r.p.m. automatic

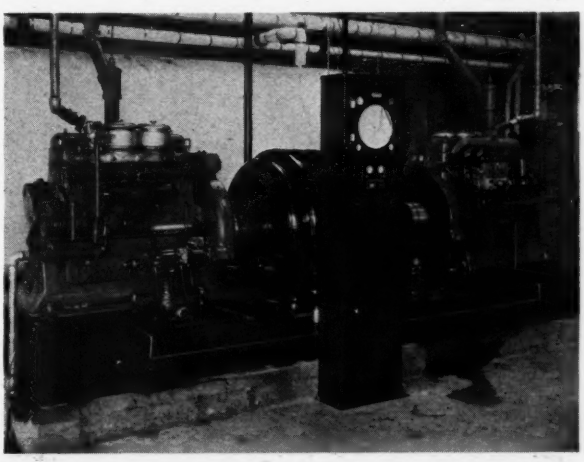


Fig. 4. 90 kw. double-ended Diesel engine driven generator at the Maclan Hat Co., Inc., East Brookfield, Mass., showing automatic balanced steam and Diesel control. A steam engine carries sufficient load to supply process steam, the Diesels carry the balance

two-engine Diesel electric generating unit also equipped with over-running clutch couplings, as shown by Fig. 4.

Both generators are 550 v., 3 ph., 60 cycle, and it was but another step to make provisions not only for operating the Diesel unit in parallel with the steam unit, but to arrange for the automatic balancing of the electric power and process steam loads during this operation. This meant simply the addition of a standard pressure control to supplement the Diesel unit exhaust temperature controllers.

Paralleling of the two generators is easily accom-

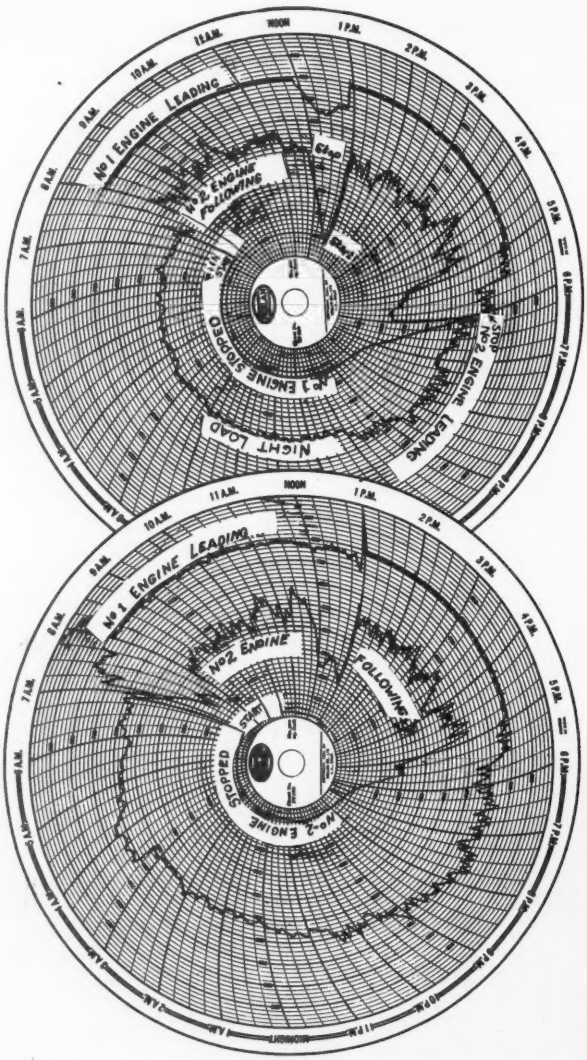


Fig. 5. Charts taken from the dual type recorder controller H. Schindler & Co., Inc., unit (Figs. 2 and 3). The exhaust temperature chart is a record of the engine load

plished by the operator from the switchboard. A control is installed on the switchboard for varying the speed of the Diesel while synchronizing. The voltage regulator is connected so that it can control the excitation of either the steam or the Diesel driven generator. When the units are running in parallel the voltage regulator controls the excitation of the steam driven generator while the excitation on the Diesel generator is controlled by hand and is set to reduce the current to a minimum or the power factor to unit.

In practice it has been found that it is advantageous to keep the Diesel generator running constantly. When the steam engine is first started at 7:30 A. M. the demand for process steam is sufficient to take the full steam output of the engine. In that case the Diesel generator merely floats on the line as a synchronous motor under no load, or, as a synchronous condenser. At about 9:30 A. M. the demand for process steam starts to lag behind the demand for power. This results in an increase in the back pressure which, through the pressure controller, automatically starts the first Diesel engine. The pressure controller then governs the power input of the first Diesel to maintain a perfect balance and uniform back pressure.

Quite frequently the demand for exhaust steam lags so far behind the demand for power that the power from both Diesel engines is required. In this event the exhaust temperature of the first Diesel, through the exhaust temperature controller, starts and controls the power input of the second Diesed engine. At 4:30 P. M. the steam engine is shut down and the Diesel unit carries the load through the night. It is also used over holidays and week-ends.

By balancing the load in this manner the owners are realizing an appreciable return of their investment made possible by eliminating exhaust steam losses. It is estimated that, because of the high back pressure, fuel alone for the steam engine driven generator costs 1.8 cts. per kw-hr. output for that portion of the load for which the exhaust steam is not used, whereas the Diesel fuel cost is not over 0.6 cts. per kw-hr. This means a saving of 1.2 cts. for every kw-hr. generated by the Diesel in balancing the load.

These installations open up an entirely new field for the application of the standardized, high speed Diesel engine. They demonstrate that a plant of almost any capacity is practical by applying a multiplicity of such units operating in parallel and automatically controlled.

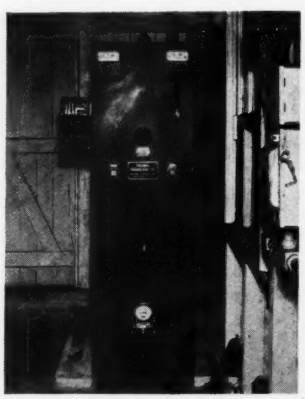


Fig. 6A. Switchboard in the H. Schindler & Co., Inc., Plant, as shown by Figs. 2 and 3 and by the recording charts of Fig. 5

Fig. 6B. Diesel switchboard panels with synchronizing equipment and Diesel engine speed control for the unit shown by Fig. 4

Low first cost and the high operating load factor, which are inherent qualities of this type of plant, will result in the lowest possible operating cost. The multiple unit plant also offers the maximum in mobility and reliability. The reliability of any plant is in proportion to its standby protection. Security is only found in numbers but with a large number of units this protection becomes virtually absolute.

PROPERTIES and Selection of Alloy Steels was discussed at a recent meeting of Buffalo Chapter, American Society for Metals, by John W. Sands of the Research Division, International Nickel Co., Inc. He covered the origin and growth of alloy steels, reasons for different specifications based upon properties and performance desired and price per pound for different alloys that will meet requirements, as well as ease of machinery and fabrication.

What Condenser Surface?

By F. A. Faville

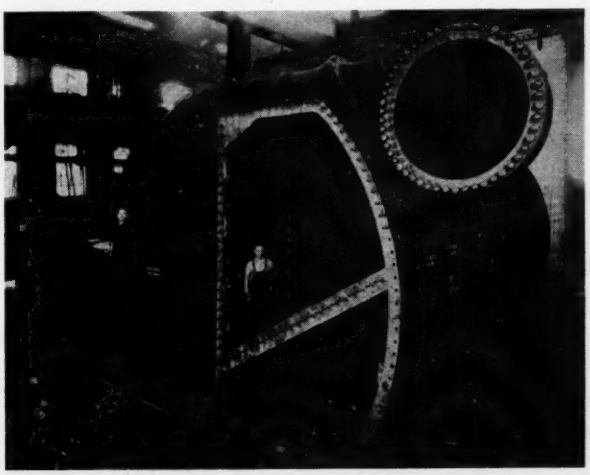
C. H. Wheeler Mfg. Co.
Chicago, Ill.

Present tendency to cut condenser surface below economic limit is the result of incomplete data and partial evaluation studies

RECENT YEARS have seen a steady accumulation of literature on condenser design, but, in spite of this, the industry generally, does not assign the importance to condensers that they deserve. Tall, stately boilers with fascinating control panels and the brilliance of "hell fire" within overshadow the less dramatic shells of the condensers hidden in the humid turbine room cellar. This lack of interest and attention in studying the condenser end of the steam cycle as contrasted with the present popularity of the high pressure end, together with certain technological advances, has resulted in an increasing tendency to purchase less condenser surface for a given application.

Of the several technical factors which contribute to this end the improved Rankine cycle efficiency of present turbine designs is a major one. A recent installation shows a 35 per cent reduction in steam for the same station load with no changes to the boiler plant. This is attributable largely to both improved turbine water rates but the improved vacuum available with present-day condenser and air removal equipment also plays its part.

Higher average steam temperatures and pressures employed today give a further reduction in steam flow for a given load, while the increased percentage of bled steam, due to the attention given to the steam cycle, stage heaters, and evaporators, decreases the percentage of throttle flow reaching the condensers. As a result, condenser costs which averaged 30 per cent of turbine costs a few years ago, today average closer to 15 per cent. In contrast with the other factors making up the total station cost, the cost of obtaining vacuum is low indeed.



Condensers of today are carefully designed, tubes, tube sheets, water boxes, baffles, air cooler section and shells all being designed to give the most effective use of cooling surface with the lowest pumping cost.

In spite of this justifiable reduction in surface it is apparent to many that the trend has gone too far and there is a real basis for the plea that excess surface in the condenser is a logical means for improving and maintaining overall station efficiency. With 400 lb. and 750 deg. F. total temperature, an improvement of 7.6 per cent in heat energy is available if the vacuum is increased from 28 to 29 in. Hg. To illustrate the magnitude of this loss, it should be noted that on the high pressure end of the cycle an increase in steam conditions from 400 lb. and 750 deg. F. to 800 lb. and 770 deg. total temperature would be required to offset the loss due to operating at 28 instead of 29 in.

Effect of Low Vacuum

Actually it is not to be expected that for prevailing water temperatures an additional inch of vacuum is commercially attainable by the mere purchase of an oversize condenser but usually an additional 0.25 to 0.50 in. is so attainable. This together with a drop of from 0.25 to 0.50 which takes place as a slight coating builds up on the water side of the formerly clean tubes, results in many units operating in the neighborhood of 1 in. below the vacuum commercially attainable. More careful attention to the low pressure end of the cycle can, therefore, result in as great an improvement in performance as can be obtained with a considerably higher boiler pressure.

To show the effect of vacuum over the entire range of back pressures from the highest theoretical value to atmospheric back pressure, the curves in Fig. 1 has been prepared. Thottle flow, for an assumed constant load of 3,000 kw. decreases from 68,400 lb. per hr. at atmospheric discharge to 34,000 lb. at 0.5 in. absolute, the highest attainable vacuum with 55 deg. F. well water available. Work done by the steam in expanding from boiler pressure to atmospheric pressure is approximately the same as that done in expanding from

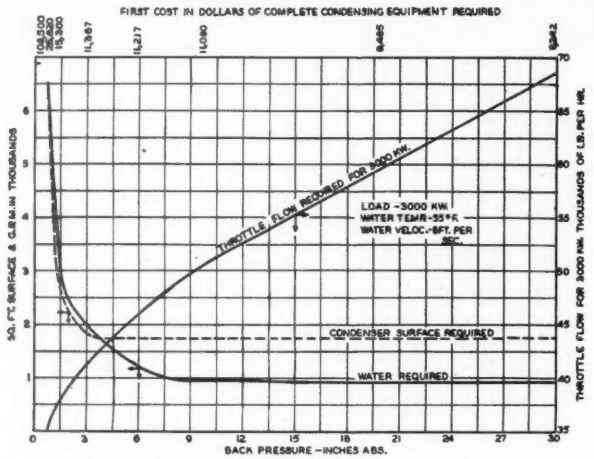

FIRST COST IN DOLLARS OF COMPLETE CONDENSING EQUIPMENT REQUIRED
SQ. FT. SURFACE & G.P.M. IN THOUSANDS
THROTTLE FLOW FOR 3000 KW. THOUSANDS OF LBS. PER HR.
THROTTLE FLOW REQUIRED FOR 3000 KW.
LOAD - 3000 KW.
WATER TEMP.-55°F.
WATER VELOC.-6FT. PER SEC.
CONDENSER SURFACE REQUIRED
WATER REQUIRED
BACK PRESSURE - INCHES ABS.

Fig. 1. The effect of varying back pressure on steam flow, condenser surface and cooling water requirements

As the back pressure is decreased the steam required for carrying an assumed load of 3000 kw. decreases rapidly, the reduction in steam flow being practically 50 per cent as the back pressure is reduced from atmospheric (30 in.) to 0.5 in. abs., the theoretical limit with the assumed 55 deg. F. water.

After about 3 in. abs. the condenser surface required is almost constant due to the greater temperature difference between the steam and cooling water and the change in steam flow. After about 9 in. abs. the water requirements are also practically constant due to the greater allowable temperature rise of the water.

Costs are shown at the top. Note that the increased cost of equipment for 3 in. abs. over that for 30 in. back pressure is negligible, but the cost of equipment for the last quarter inch from 0.75 to 0.5 in. increases the cost over 400 per cent.

atmospheric pressure down to vacuum. As a result the steam flow at high vacuum is only one-half that at atmospheric discharge.

Condenser surface and circulating water were calculated according to commercial practice, using conventional design, and a constant water velocity of 6 ft. per sec. A change from two-pass to four-pass design was made at 6 in. absolute and the change is reflected in the reduced ratio of water required to surface at the higher back pressures. The surface and water required are not really constant at back pressures in excess of 6 in. absolute, but merely appear to be so on the scale used. The increase in steam flow at increasing back pressures just about compensates for the decreased surface and gallonage requirements that would result from the increasing temperature differences at higher back pressures and with a constant steam flow.

From this data, first cost, capitalized pumping cost and capitalized excess steam cost, over that required at 0.50 in. absolute are plotted on Fig. 2. Summation of these curves gives total operating charges for this particular set of operating conditions. While for a specific installation the operating conditions may be modified somewhat, the general shape of the total curve will remain the same.

Boiler Room Costs

Note that when corrected for increased steam flows at higher back pressures, the surface, water cost and first cost increase only a few percent until a back pressure of 3 in. absolute (or 27 in. referred to a 30 in. barometer) is attained. In other words, the cost of merely collapsing the exhaust steam to be available for distilled boiler feed amounts to $9242.00 and this cost increases to only $11,217.00 for condensing equipment capable of producing 27 in. of vacuum. The saving due to reduced steam flow is obvious from the steam flow curve. The reduction in boiler room capacity from 68,000 to 34,000 lb. per hr. of steam over the range plotted makes it obvious that the condenser reflects a saving in investment required in the boiler room. On the majority of jobs, however, actual evaluation does not give the condenser its proper credit for reducing boiler room investment, and, thus tends to justify a smaller condenser than should be the case.

Maintenance

Again, the poor, old condenser "takes it on the chin" for the high maintenance involved in the burning of coal in a boiler furnace, either with or without waste heat equipment. The assumed maintenance figure is inclined to take total plant repairs and pro-rate for the various equipment involved. Condensers are relatively trouble and maintenance free, except for periodic cleaning. Many plants do not clean at all. If an over-sized condenser is purchased, the fixed charges on the investment are smaller than the same amount of money spent in the boiler room. This is due both to the long life of condensing equipment, of which only the auxiliary pumps run at all, and the very low maintenance, as only low temperature and pressures prevail and non-ferrous alloys are highly resistant to corrosion.

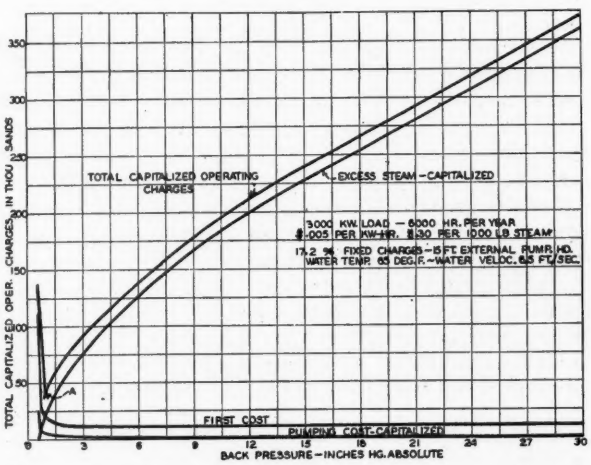

TOTAL CAPITALIZED OPER. CHARGES IN THOUSANDS
TOTAL CAPITALIZED OPERATING CHARGES
EXCESS STEAM - CAPITALIZED
3000 KW. LOAD - 6000 HR. PER YEAR
$.005 PER KW-HR. $.30 PER 1000 LB STEAM
17.2 % FIXED CHARGES - 15 FT. EXTERNAL PUMP HD.
WATER TEMP. 65 DEG. F. - WATER VELOC. 6.5 FT./SEC.
A
FIRST COST
PUMPING COST-CAPITALIZED
BACK PRESSURE - INCHES HG. ABSOLUTE

Fig. 2. Total capitalized operating costs over the entire range of back pressure

The lowest theoretical back pressure with 55 deg. F. water is 0.5 in. abs. Steamflow at this point is used as a base and additional steam flow at higher back pressure used in calculating the excess steam cost.

Evaluation over the entire range of back pressures is unnecessary and the engineering involved for complete evaluation of a unit as small as 3000 kw. is rarely justified. Let us, therefore, consider the actual evaluation of a 35,000 kw. unit, where such detailed studies were made. In effect, such a study becomes an enlargement of Fig. 2 at its critical point (point A), corrected, of course, for the different temperatures and conditions of operations for the unit considered.

Figure 3 indicates such studies with curve A made up to show comparison of a group of condensers, with commercially clean tubes. Sizes selected give vacua for each 0.1 in. over the critical range to be evaluated.

From curve A of Fig. 3 it is obvious that a condenser of approximately 25,000 sq. ft. would be justified from such an evaluation, characteristic of the tendency to justify too small a condenser. Actually, curves were prepared for several water velocities, and optimum values plus other commercial considerations limited studies to the 6.5 ft. per sec. velocity used.

Basic Assumptions

In curve B in Fig. 3 the evaluation considers average operating difference in vacuum for each condenser (as explained later in connection with Fig. 5) in place of the vacuum available with commercially clean tubes. The result indicates that a condenser of 33,500 sq. ft. is justified. This condenser is characteristic of surface being purchased today for a unit of this capacity. Investments are cut close but such a unit will perform satisfactorily.

In the above evaluation, however, power is charged against the condenser at approximate cost to a base load customer plus a station investment cost. Steam saved by larger condensers, however, is only credited at actual fuel cost. To credit the condenser with station investment, that is the cost of boiler capacity saved, will show a return as on curve C of Fig. 3, from which a 36,500 sq. ft. condenser would be justified. This will be a definitely more satisfactory unit in service than the smaller condenser and each additional square foot of surface is earning money for its owner every hour it is on the line, regardless of water temperature or load on the turbine.

To simplify the illustration, only full load figures are given. This is possible only after part load studies have been made and suitable costs, hours per year and other factors established so that load and the value of 0.1 in. of vacuum represent suitable integrated averages of all of the operating conditions.

Careful studies of existing and anticipated loads indicated that this steam flow over 4,000 hours of operation represented the average of the yearly load. Fixed charges will, of course, vary, according to the standards of the particular plant in question. The

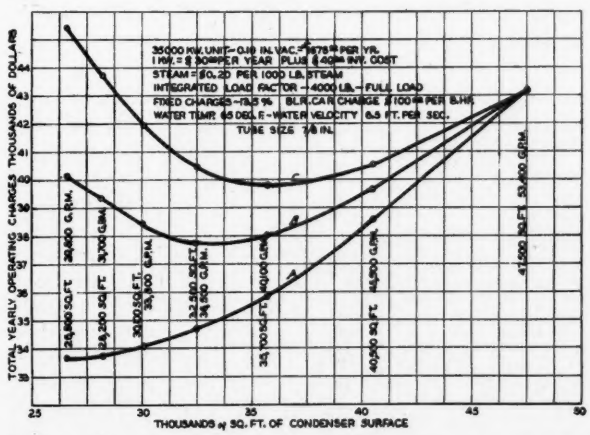

35000 KW. UNIT—0.10 IN. VAC. = 378 M PER YR.
1 M. = $ NUMBER YEAR PLUS $ 40 M INV. COST
STEAM = $0.20 PER 1000 LB. STEAM
INTEGRATED LOAD FACTOR — 4000 LB. — FULL LOAD
FIXED CHARGES — 18.3 % B.T.R. CAR CHARGE $100 M PER B.H.P.
WATER TEMP. 65 DEG. F. — WATER VELOCITY 6.5 FT. PER SEC.
TUBE SIZE 1" O.D.
TOTAL YEARLY OPERATING CHARGES THOUSANDS OF DOLLARS
THOUSANDS of SQ. FT. OF CONDENSER SURFACE
24,800 SQ.FT
29,250 SQ.FT
33,500 SQ.FT
36,250 SQ.FT
40,000 G.P.M.
45,000 G.P.M.
47,500 SQ.FT. 53,400 G.P.M.

Fig. 3. Economic return curves for a 35,000 kw. unit. The complete evaluation in curve C adds approximately 50 per cent to the surface of the most economic condenser

Curve A is based on commercially clean tubes; Curve B considers the fall off in vacuum over a period of years as shown by Fig. 5; Curve C, in addition to the drop-off in vacuum with age, gives credit to the condenser for reduction in boiler room capital costs due to the reduction in steam flow.

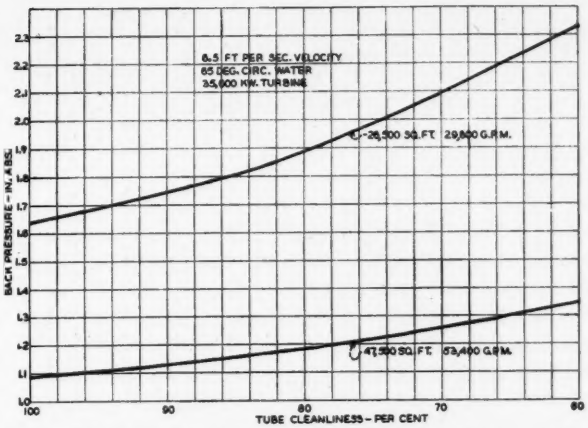

6.5 FT PER SEC. VELOCITY
65 DEG. CIRC. WATER
35,000 KW. TURBINE
C-36,500 SQ.FT. 29,800 G.P.M.
47,500 SQ.FT. 53,400 G.P.M.
BACK PRESSURE - IN. ABS.
TUBE CLEANLINESS - PER CENT

Fig. 4. Tube cleanliness plays a big part in determining the vacuum that the condenser will carry. The increase in back pressure is much less with oversized condensers and the two sizes selected for comparison are the extremes indicated by curve A of Fig. 3. One is too small the other too large for the assumed conditions but they are used here to emphasize the importance of size and its relation to the effect of the cleanliness factor

matter of auxiliary power cost is usually one of considerable controversy. The figure used for this item will vary from the basis given in the preceding paragraph down to the equivalent coal cost per kw.-hr. The important consideration is that the value of 0.1 in. of vacuum shall represent a suitable value for the operating conditions prevailing at the plant in question.

In practice tubes cannot be kept from fouling and Fig. 4 shows two of the condensers considered, plotting vacuum produced for varying percentages of tube cleanliness. It is noticeable that the larger condenser loses vacuum much less rapidly than the smaller machine. That this should be so is simple enough considering the fundamental heat transfer formula

$$Q = S\,U\,D \qquad (1)$$

where:

Q = B.T.U. per hr. to be transferred from the steam to circulating water.
S = Condenser surface in square feet.
U = Coefficient of heat transfer expressed as B.T.U. per deg. F. Mean Temperature Difference per Sq. Ft. per Hr.
D = Mean temperature difference.

When the arithmetic mean temperature difference D_A is used

$$D_A = T_S - \frac{t_1 + t_2}{2} \qquad (2)$$

where

T_S = steam temperature
T_1 = circulating water temperature in
T_2 = circulating water temperature out.

For logarithmic mean temperature difference D_L is used

$$D_L = (t_2 - t_1) \div \log_e \left(\frac{T_S - t_1}{T_S - t_2} \right) \qquad (3)$$

Assume for a given Condenser that the total heat flow in B.t.u

$$Q = 1{,}000{,}000$$
$$S = 100$$
$$U = 500$$

then

$$D = \frac{Q}{S\,U} = \frac{1{,}000{,}000}{100 \times 500} = 20 \text{ deg. F.} \qquad (4)$$

For 50 per cent clean tubes, U would become 50 per cent of 500 or 250 and

$$D = \frac{1{,}000{,}000}{100 \times 250} = 40 \text{ deg. F.} \qquad (5)$$

Consider now a condenser of the same velocity, G.P.M. and heat transfer design, but of double the surface and for the same B.t.u. to be condensed.

$$\text{D now becomes } \frac{1{,}000{,}000}{200 \times 500} = 10 \text{ deg. F.} \qquad (6)$$

and for 50 per cent clean tubes:

$$D = \frac{1{,}000{,}000}{200 \times 250} = 20 \text{ deg. F.} \qquad (7)$$

Using arithmetic differences for simplicity, and circulating water heated from 70 to 90 deg. F. in all cases, mean water temperature, or $(t_1+t_2)\div 2$ becomes 80 and steam or vacuum temperature for (4) would then be 80+20 or 100 deg. F. and for (5), 80+40 or 120 deg. F., corresponding to a loss in vacuum of 1.47 in. With the larger condenser, the vacuum temperature clean (6) is 80+10 or 90 deg. F. and for 50 per cent clean tubes, (7) is 80+20 or 100 deg. F., corresponding to a loss in vacuum of but 0.51 in. The effect of tube cleanliness is shown graphically by Fig. 4.

To allow for fouling of the tube surface, many units are purchased today on the basis of "tubes 80 or 85 per cent commercially clean." The insertion of this factor of safety is very commendable. All data used here is in accordance with "Commercial Factors for Designing Surface Condensers," Power, September, 1932, which explains how factors used for "commercially clean tubes" take into consideration a slight coating on the water side of the tube as there are comparatively few sources of circulating water supply that do not contain substances which will foul the water side of the tubes to a certain degree.

This is necessary and advisable as it is almost never possible to test a condenser until at least sufficient water has been pumped through it to deposit the slight coating above referred to. It is also true, in those rare cases where waters do not contain contaminating substances, that condensing equipments are in yearly operation showing heat transfers in excess of 20 per cent better than the "commercially clean" heat transfer guarantees the manufacturer allows.

In most cases, a condenser will not be taken out of service to be cleaned until there is a very noticeable fall-off in vacuum. It is typical of average operation to allow a condenser to run until a vacuum corresponding to 60 per cent clean is obtained, although, of course, this is subject to considerable variation, depending on operating personnel. For comparative purposes, assume the 26,500 and the 47,500 sq. ft. units shown are operated until 60 per cent clean before taking out of service. The average vacuum available over the operating period to produce such fouling will then be the mean between vacuum obtained with commercially clean tubes and 60 per cent clean tubes or 1.89 and 1.19 in. absolute instead of 1.64 and 1.09 in. absolute available with clean tubes. A comparison of expected performance and economy should more properly be made on this basis and such an evaluation is shown by curve B of Fig. 3.

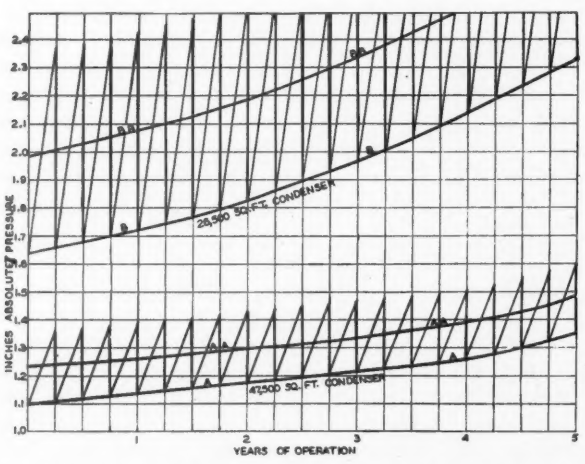


Fig. 5. Over a period of time there will be a gradual decrease in vacuum due to fouling of the tubes. In the above curves the condensers are cleaned when the cleanliness factor drops to 60 per cent. This cleaning does not bring the tube back to its original condition, however, and the average vacuum carried over a period of time is shown by curves AA and BB. The effect on the oversized condenser is small compared with the smaller unit

Effect of Age

After a period of years in operation, original vacuum obtained is no longer available with many condensers. In most cases, this is due to the inability to completely restore the cleanliness of the tube with the method of cleaning used. While sand-blasting and acid cleaning will normally completely restore the tube cleanliness to its original condition, this type of cleaning may not be used, so many units are operating at substantially reduced transfer rates.

Figure 5 illustrates what will happen in service with each of the condensers shown on Fig. 4. In both cases, it is assumed that units will foul to the 60 per cent clean stage in 3 mo. of operation, with resultant loss of vacuum as shown. Upon cleaning, the vacuum is restored but not quite to its original condition. Each condenser is assumed to fall to 60 per cent of the clean tube transfer at the end of 5 yr. of operation. Average vacuum over this period will not be the vacuum available after mechanical cleaning, as curves A and B, but the mean vacuum between the clean and dirty condenser, or AA and BB. From curves, the average over the 5-yr. period considered is 1.31 and 2.25 in.

It is always possible to operate a turbine unit with condensers of reduced size. However, excess surface in the condenser creates good-will in: Reducing peak load boilers must carry; better ratio maintenance costs against investment than any other equipment making up primary station costs; less cleaning than when purchasing smaller condenser; extra economy available against smaller condenser reflected for all operating conditions; excess surface reflected in corresponding reduction in water requirements.

Conclusion

The impression is often given that the evaluated size of a condenser for a given application can be worked out to an exact size. At best, assumptions made will give only a general answer. If the size justified in the paper evaluation is increased arbitrarily from 15 to 20 per cent, a better operating unit will be obtained. It must be remembered that first costs are soon forgotten, but operating costs go on each year. It is the obligation of the manufacturer to produce condensers for the best possible performance per square foot of surface. The prospective purchaser can do little to influence the design itself, but can insure a satisfactory operating unit by subordinating the idea of a low square foot per kilowatt ratio in favor of the idea that return on excess surfaces purchased in a condenser will pay dividends both in steam savings and satisfactory operation.

Turbine Supervisory Instruments

DEVELOPMENT of accurate and dependable telemetered recording instruments for the protection and supervision of large turbines, by remote control, was described by J. L. Roberts and C. D. Greentree, both of the General Electric Co., in a paper presented to the annual meeting of the A. S. M. E. These instruments measure and record the shaft eccentricity, bearing vibration, shell expansion and detect interference or rubbing of rotating parts. In the starting, stopping, and normal running of turbine generators, it has been necessary to rely on the accumulated experience from the operation of previous units to assure safe and successful performance.

Starting cycles and normal running instructions were prepared by manufacturers for individual units, recommending the procedure to follow. The recommendations were based on observations of hundreds of machines in service and, in general, have provided safe but conservative technique for individual machines. Based on experience gained with individual units, operators have modified their practice. Unusual conditions both within and without the turbine influence the manner in which the turbines should be operated.

Variations Recorded

Recording instruments show the presence of these unusual conditions and will enable the operator to make changes required in his operating procedure, thus avoiding, to a great extent, probability of injury to the turbine. Each of the four instruments use approximately 150 watts at 115 v., 60 cycles. The recorder charts are Telechron motor driven at a rate of 3 in. per hr., and the standard chart length is equivalent to one week's operation.

The complete eccentricity recorder consists of the recording instrument and the control unit mounted on a panel shaft ring, the detector coil, mounting yoke, switch, and motor-generator set—the latter to supply 500-cycle power. The detector coil is mounted on a yoke attached to the turbine foundation and presented to a ring on the turbine shaft. The eccentricity or wobble of the shaft induces variation in the 500-cycle current, which is fed into the control unit, whose output operates a photoelectric recorder. The recorder measures shaft eccentricity in thousandths of an inch from turning-gear speed to synchronous speed. The range of measurement is from one 0.001 to 0.00001 in. at full scale deflection. Two ranges of sensitivity automatically controlled are provided, one for operation at turning-gear speed and the other for all higher speeds.

Vibration amplitude recorder includes the recording instrument, amplifier, time switch, detector units, and a panel-mounted push-button station. A vibration detector unit is mounted on each of the turbine bearings on which the vibration is to be measured. Through the amplifier the detector output is connected to and operates the recorder. The latter is of standard type with full scale deflection equal to 0.01 in. and having 0.001 in. scale divisions. Vibrations as small as one-fourth of a mil may be measured. Bearing vibration can be recorded at any frequency from 10 to 60 cycles per second for 1800 to 3600 r.p.m. machines.

Complete expansion recorder consists of a recording instrument, panel mounted, and the displacement unit. The relative axial motion between the turbine shell and the foundation operates a displacement unit placed where it is desired to measure the expansion. The remote recorder indicates expansion from cold condition on a linear scale graduated in tenths of an inch.

Loud Speaker

Included in the complete interference detector are a high-gain amplifier, panel mounted, together with a loud speaker and one or more detector units. The device has a relatively flat frequency response characteristic extending into the upper range of audibility, whereby faithful reproduction of the turbine noises can be obtained. The detector units may be placed where required on the turbine, and may be connected as desired to the loud speaker which gives a more accurate indication than is possible to obtain with the usual listening rod.

Life of Turbine Oils*

Safe Turbine Operation Requires Continuous Check on the Condition of the Lubricating Oil

By Walter C. Ames, Jr.[1]

AFTER OIL with proper characteristics is chosen for a turbine, the operator is interested in how long he can use a batch with security. Subjected to heat, pressure, and oxygen in the air, characteristics will change, gradually, then more rapidly, so that, even if kept free of foreign matter, a time will come when the oil shows signs of distress. Sludge is most troublesome, since it will plug orifices, thus reducing supply, and is not itself a satisfactory lubricant.

Lubricant is the life blood of the machine, and, if the operator were sure that he could control sludging, he could check mile posts in the aging of the oil up to the end of its economical life.

Tests used are, the neutralization number of milligrams of KOH per gram of oil to neutralize acidity, viscosity, specific gravity and demulsibility. Use of the centrifuge will show whether sludge or water is present, and appearance of a sample after being chilled or allowed to stand a few days tells something of its condition. But, it is believed that none of these gives the whole answer and, in particular, the neutralization number cannot be relied on to tell when the oil is no longer safe to use.

Accelerated aging tests may give curves with which results in actual operation may be compared, but laboratory and plant conditions are dissimilar, hence too much reliance cannot be placed on such comparison. Usually, oil is changed often to avoid any possibility of over-long use. While cost of a new batch of oil is not large as compared to total plant operation cost, over a term of years total oil cost mounts up and can be reduced, if life of the oil can be extended without detracting from safety.

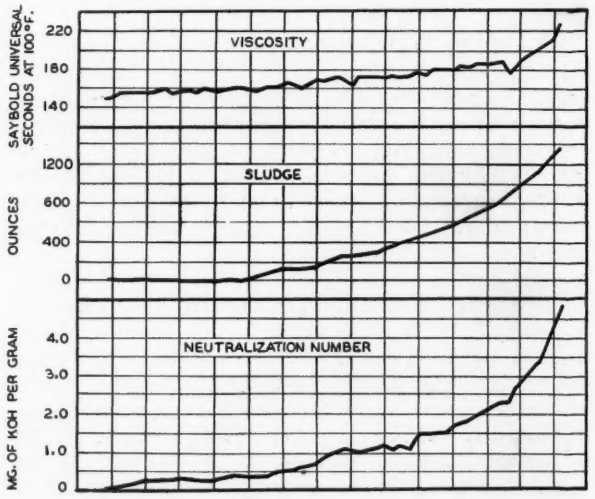
Used in a turbine for long periods, some of the hydrocarbons in oil break down, forming acid products, part, if not all, being soluble in water, and some or all forming sludge. If allowed to accumulate, a point will be reached where sludge will be thrown down, especially if water leaks in through oil coolers and seals. The emulsion of oil and water will carry sludge in suspension to all parts of the oiling system, depositing it on oil cooler surfaces and in many other places. Also water which absorbs acids becomes corrosive and may make trouble in piping and at bearing surfaces.

It is believed that every oil has a saturation point for soluble products and that, if broken down hydrocarbons are removed to keep the amount below this saturation point, no sludge will be thrown down.

The neutralization number measures both insoluble and water soluble acids, but only the latter have been shown to cause sludge, the former showing no harmful effects. So the neutralization number does not necessarily indicate when an oil is likely to cause trouble.

Sludge can be removed by a centrifuge but, after the oil begins to break down, considerable sludge may be deposited in the system before oil reaches the separator. This entails cleaning of reservoirs, piping and coolers, which is costly and requires outage of equipment.

Bypassing a small part of the oil, 1 to 2 per cent, continuously to a warm water wash, mixing the oil and water thoroughly, and passing the emulsion through a separator then back to the machine reservoir will throw down much of the dissolved sludge



Variation of Oil Conditions, with Age, when regularly washed and centrifuged

*Abstract from a paper presented to Edison Electric Institute for the McGraw Prize.

[1]Public Service Elec. & Gas Co., Kearny, N. J.

and remove much of the water soluble acids, and it has been found possible thus to keep sludge out of the system.

Three case studies are shown in the paper. In one, cleaning of the system once a year was necessary, appreciable amounts of sludge being removed each time, and sludge removed by the separator being negligible. After the bypass washing was started, about a pound of sludge a week was removed by the separator, but this stopped when washing was discontinued. With washing one week in three, until sludge deposit in the separator becomes negligible, no cleaning of the system has been necessary, but more continuous washing will undoubtedly be necessary as the time that oil has been in service increases.

In a second case, the neutralization number showed an alarming rise but, after starting the washing, this was reduced and the oil continued in service, no further cleaning of oil coolers being needed. In a third case, where washing was used from the start, the system was clean at all times until the oil definitely broke down at a neutralization number of 2.3 mg. of KOH per gram of oil, after a long period of service as shown in the illustration. Even then, the oil was kept in use until a neutralization number of 4.9 was reached, much higher than usually allowed, without deposit of sludge in the system, though the sludge removed in the separator increased quite rapidly after the break-down point of the oil was passed.

The records indicate that, with a washing and separating system in use, by periodically testing the viscosity, amount of sludge removed by the separator and neutralization number, the break-down point of the oil can be determined by the change in slope of the curves, and that oil will remain in satisfactory condition, with little or no deposit in the system even somewhat beyond the break-down point, so that time for changing the oil can be selected at convenience, within a reasonable period.

Just how much this method will extend useful life of the oil is uncertain but it will probably double the time of service, and avoid cleaning of piping and coolers.

Smoke Abatement

AT A MEETING on this subject sponsored by the Appalachian Coals, Inc., held in Cincinnati, many interesting papers were presented giving valuable hints and experiences. As was natural, the main requirements for smokeless combustion were treated in all the papers, hence a compsite abstract of the features of all papers is given as the best method of summarizing the points emphasized.

Fundamental conditions as stated by several authors are Time for complete combustion, Temperature to ensure proper combustion, and Turbulence to give thorough mixture of air and combustible gases.

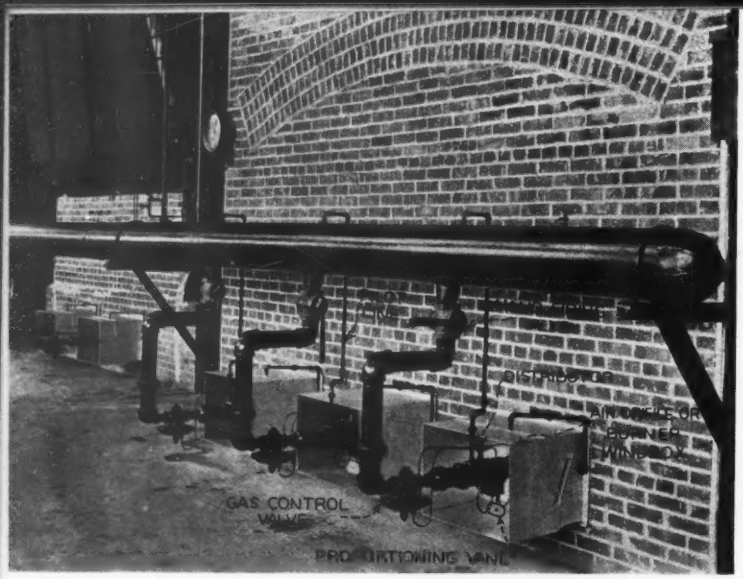
In the matter of equipment for combustion, T. P. Bateman stated that for single-retort stokers, water-cooled walls often give a low furnace temperature and free-burning coal is needed, or, as T. R. Workman suggested, refractories should be applied to front or side walls to increase furnace temperature. Slag accumulation on the walls may improve combustion, but are likely to lower efficiency. J. F. Barkley recommends for bituminous coals a 14-ft. horizontal flame travel to give better mixing than vertical travel and to drop out fly ash. Also cross-fire steam-air jets at the front corners of the furnace, pointed downward toward the bridge wall for the same purposes. W. G. Christy also favors steam jets to be used, especially after fresh firing, but Mr. Bateman and E. J. Kerr feel that air penetration of such jets from the front may not be deep enough and favor air supplied through the rear wall or through nozzles in the front arch at a blower pressure of 6 in. of water.

William Culbert stated that in Nashville, to be on the safe side, all installations of 12 boiler horsepower or over are required to have underfeed stokers or pulverized fuel furnaces. He gave as a safe rule of thumb that, for each 100 ft. of steam radiation, 5 lb. of coal should be figured as burned per hour and 1 cu. ft. of combustion space should be provided for each 3 lb. of coal burned per hour. For stokers, if extra air is supplied over the fire to give a short flame, less combustion space will be needed.

In choosing fuel, Mr. Christy felt that special care should be used to get a fuel of qualities and size suited to the furnace, especially for one-retort stokers. In pulverized fuel plants, Mr. Bateman cautioned the need for watching the mills to be sure that they give fuel of required fineness, as worn mills may lose somewhat in effectiveness and coarse particles will result in smoky combustion. A cold boiler should be started slowly and changes in steam demand anticipated to avoid rushing. Feedwater regulation should be held steady to even up the heat demand on the furnace. Regulation of primary air to a moderate nozzle velocity will give a "lazy" flame bed, according to Mr. Workman, and more time for combustion of low volatiles in the fuel bed; secondary air supplied above the ash hopper at right angles to flame travel and controlled by shutters will help reduce smoky tendency. Mr. Christy emphasized that pulverization must be finer as percentage of volatile is less and ignition temperature lower.

When using spread-firing stokers, care must be exercised, said Mr. Barkley, as they are sensitive to control and too much fuel for the air, due to slight change in the fuel feed, may cause smoke. For chain grates, Mr. Kerr felt that tempering the coal with water or low-pressure steam aids in maintaining good fuel bed conditions, which aids good combustion.

As an aid to adjusting air supply to coal feed, Mr. Christy advocates a smoke indicator with an alarm signal, to guide and caution the firemen. Use of hoes and slice bars should be as infrequent as possible, with no top firing when banking underfeed stokers. Controls for draft and fuel feed should be near the gages, said Mr. Bateman, meters and gages being checked periodically. Mr. Workman advocated provision for observation of pulverized fuel combustion from 1 ft. beyond the fuel nozzle up to the base of the stack to avoid excess primary air and too much draft. Change of coal should be watched. In one instance, coal was changed to a 28 per cent volatile without notice to the engineer, which resulted in dense smoke and discharge of coal particles from the stack.



The Webster Engineering Co. Weco Precision Control for Gas Fuel

COMBUSTION CONTROL

GAS OFFERS many advantages as a fuel and of recent years the ever growing network of pipe lines has greatly increased the territory where natural gas is available at a price competitive with oil and coal. Rapid increases in the number of gas fired boilers has led to increased development work by manufacturers to meet the more diversified needs. One of the manufacturers in this field, The Webster Engineering Co., for many years has specialized in burners, regulators and auxiliary equipment for gas firing, and during the past 5 yr. has been active in the development of an automatic control system designed especially for gas fired boilers. This was recently put on the market and is known as the Weco Precision Combustion Control of the draft compensating type.

Basically, the system consists of a steam pressure regulator or master controller (called in this system the Motor Modulator) for controlling the air supply in accordance with the load, and, a proportioner for maintaining the desired gas-air ratio. The control is applicable to all types and sizes of boilers and the various elements are grouped into standard combinations designated as Series 1, etc., up to Series 15. These different series meet manual and automatic requirements of plants ranging from the "on and off" domestic boiler to a complete power plant. The system is applicable to natural or forced draft and may be hydraulically, electrically or gas pressure operated.

In the simplest form the control consists of a motor modulator, Fig. 2, which actuates a motor control to operate the boiler outlet damper and the gas valve. In this form the control is designated as "non-draft compensating," and the gas-air ratio is fixed by the relative position and the characteristics of the damper and gas valve. By adding the proportioning device, Fig. 3, the draft compensating feature is incorporated and the CO_2 or gas-air ratio may be kept at a predetermined value over the load range and the boiler efficiency increased. Depending upon the type of plant and its operation, various combinations such as a single proportioning device, or, gas valve for the entire plant, or, for each boiler, or, for each burner, may be used. These simpler controls will, however, be passed over and only the most comprehensive all automatic combinations applicable to natural and forced draft plants with several multi-burner boilers will be described.

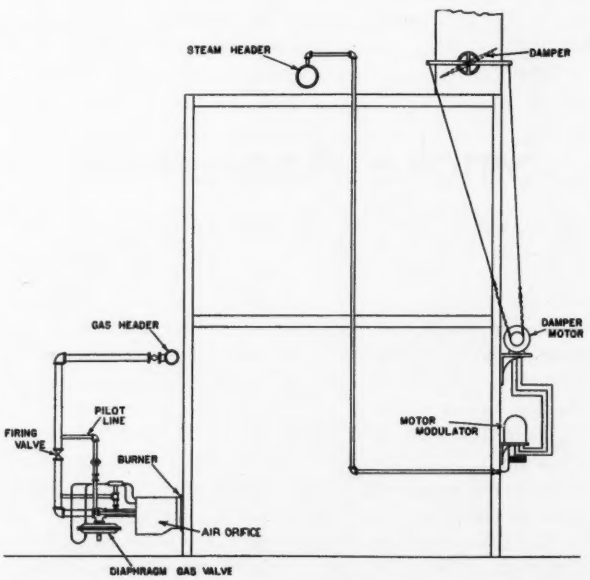


Fig. 1. Arrangement of the Weco Control (Series 1) for natural draft. This consists essentially of the Motor Modulator (Fig. 2) for operating the damper and a proportioning device, Fig. 3, to control the gas-air ratio. The position of the proportioner in the burner air orifice or windbox is clearly shown in the headpiece

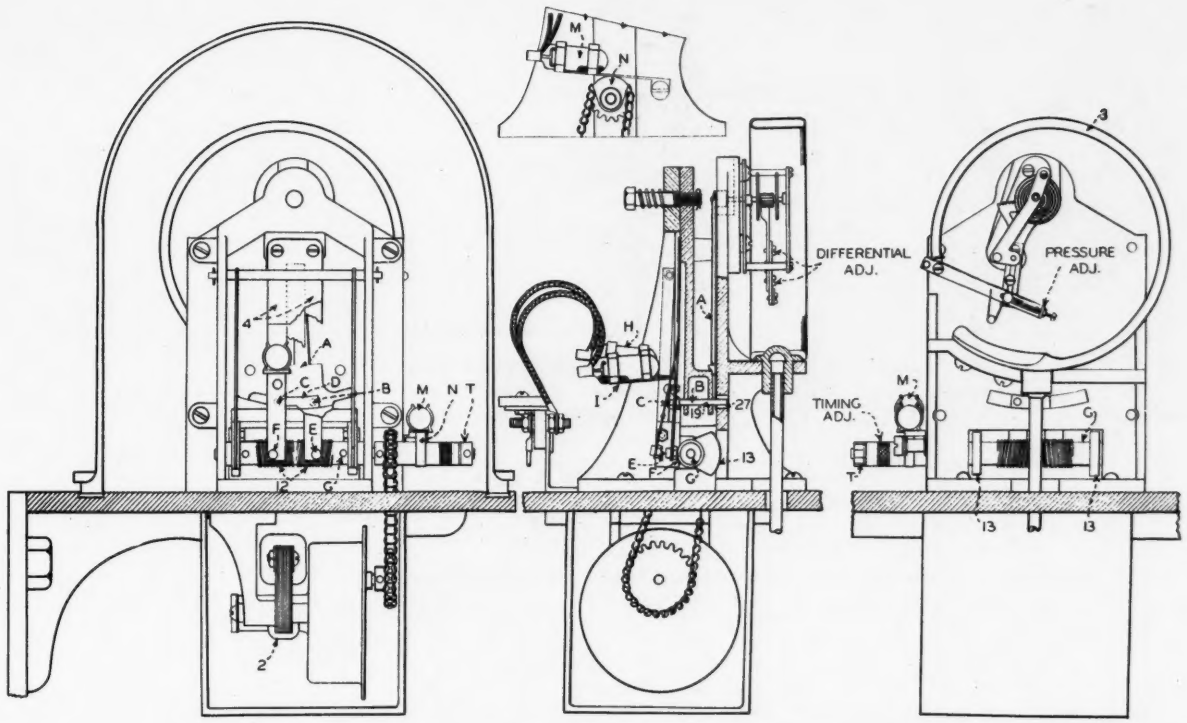


Fig. 2. The damper operator or Motor Modulator is actuated by steam pressure and controls the damper

This type of damper mechanism is used for both the Series 1 (Fig. 1) and Series 15FD (Fig. 4) controls. The modulator is actuated by changes in steam pressure on Bourdon tube 1. Through the mechanism explained below the Bourdon tube moves mercury switches H or I to close one circuit of a high speed, reversible geared motor drive and move the damper in the proper direction. The size of this motor depends upon the necessary damper pull required by a particular plant.

In addition to the bourdon tube and connecting mechanism which moves pendulum A, the modulator has a Telechron motor 2, driving at constant speed, shaft G carrying cams N and 13 and right and left hand threads 12. Mercury switches H and I are mounted on spring strips 4 which also carry pins B, C, E and F. These strips are lifted periodically by a lift bar under the action by cams 13. Pins B and C fit through slot D of pendulum A which is so arranged that either B or C or neither will pass through depending upon the relative position of pendulum A and the mercury switch assembly at the time. D is so designed that both B and C cannot pass through at the same time.

If upon release by the lift bar either pin B or C drops through slot D, mercury switch H or I tilts and closes the damper motor circuit. At the same time compensation is provided by pin E or F, engaging threads 12 so that the entire switch assembly is carried to the right or left (depending upon which pin is engaged) until the pin is disengaged from the threads by the next cycle of the lift bar L. As pin B or C is pulled out of the slot, pendulum A is free to take a new position if there has been a change of steam pressure in the meantime.

If the damper movement during this time has been sufficient to give the desired effect and there has been no change of steam pressure, neither B or C will pass through slot D during the next cycle and no further movement of the damper takes place at that time. In case the movement has not been sufficient, or if the pressure has changed, one of the pins will drop through as before and the damper will move another step. The length of damper motor operation at each contact may be limited or timed by means of timing adjustment T which controls the position of cam N on shaft G. The position of cam N controls the operation of mercury switch M to open the motor circuit after a predetermined period of operation.

Adjustment of normal pressure held by the modulator may be made at the bourdon spring linkage as indicated in the drawing at the left while the differential pressure, that is, the pressure variation between full and no load, may be adjusted as indicated in the middle drawing. This differential adjustment may be varied from about 1 to 20 lb. plus or minus. The steam pressure range for each size Bourdon tube is about 50 lb. Application of the motor modulator is shown by Figs. 1 and 4.

Figure 1 shows the application of the control (Series 1) to one of several natural draft boilers, each boiler fired by one or more gas burners. There is one motor modulator, Fig. 2, for the plant and one proportioning device, Fig. 3 for each burner. For simplicity but one boiler and one burner is shown but the headpiece would be typical of a plant of this kind. Variations in steam header pressure actuate the Motor Modulator to move the uptake damper of all boilers in unison. As the position of the damper changes, it affects the furnace pressure and consequently the quantity of air drawn in through the burners. If the steam pressure decreases, due to an increase in load, the Motor Modulator acts to open the damper. This increases the draft in the furnace and draws more air in through the air orifice or burner windbox.

As the air flow changes, the proportioning device, Fig. 3, operates to change the gas flow and maintain the predetermined gas-air ratio. All parts of this proportioning device are outside the furnace and are affected by the furnace pressure only as it influences the air velocity through the windbox. A moment, due to the velocity of the air in the air orifice or windbox acting on an air vane, is opposed by a moment due to the velocity of the gas on a gas vane. Any unbalance of moments, due to changing furnace, atmospheric or gas conditions, tends to rotate the vanes and open or close leak ports.

As explained in detail by Fig. 3 and 5, these leak ports control a diaphragm valve in the gas line so as to bring the gas-air ratio to the desired value. This ratio may be changed by adjusting the length of the air vane lever arm. Lengthening the arm increases the moment due to the air velocity, thus decreasing the excess air and raising the CO_2. As the gas velocity increases, the vanes are brought to neutral position and the gas valve locked in position.

Gas pressure for operating the system is taken from the high pressure side of the gas valve and introduced through the center of the distributor, a detail of which is shown in Fig. 3. Through orifices and copper tubing the gas pressure is led to the top and bottom of the gas valve diaphragm and to the two leak-off ports on the proportioning device. These leak-off ports have smali

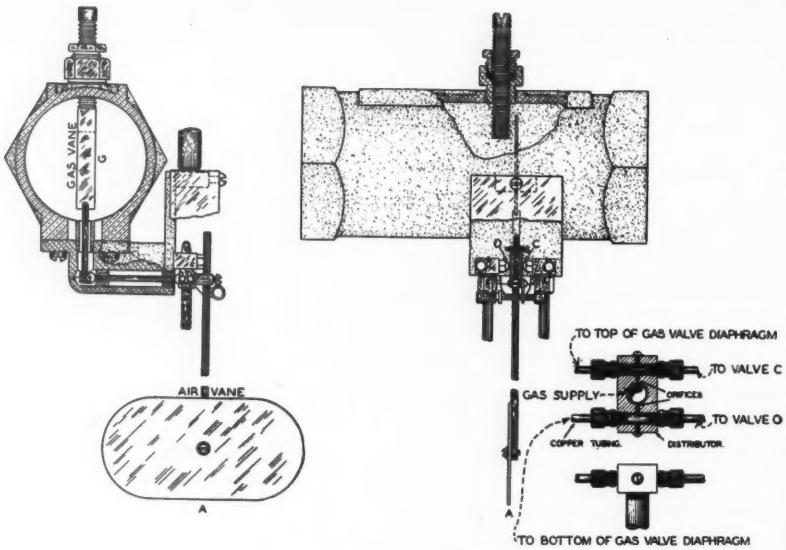


Fig. 3. Proportioning of the gas and air under all conditions of furnace draft and gas pressure is accomplished by the use of a vane type proportioning device, one of which is placed on each gas burner. The insert shows the construction of the distributor for the operating gas pressure.

Operation is as follows: Damper position (changed by damper mechanism Fig. 2) through variations of steam pressure controls the draft in the furnace. (Draft in furnace may also be changed by atmospheric conditions without movement of damper.) If the draft is increased, air flow passing the air vane is increased. This causes the air vane to move forward, closing orifice O to build up a pressure (through the action of the distributor), on the lower side of the diaphragm of gas valve. This pressure starts to open the valve and the movement continues until the increased gas flow passing gas vane G balances the force of the air on vane A. When pressures on gas vane and pressure on air vane are such that vane remains in a vertical position, the air-gas ratio is correct for proper combustion and both orifices O and C are open. Pressures on both the top and bottom of gas valve diaphragm are equal and the valve remains in this position until there is another change in draft or gas pressure. In the case of increased gas pressure, the flow of gas passing gas vane G will cause this vane to move forward overbalancing the air vane and closing orifice G.

Adjustment for CO_2 is made as follows: To increase the CO_2 the air vane is lowered. This increases the amount of gas necessary to balance the vanes in a vertical position. To decrease the CO_2 move air vane upward thereby reducing the ratio of gas to air. Having a proportioning device and gas valve on each burner permits cutting off of individual burners without disturbing the control of the burners remaining in operation. It also compensates for unequal draft across the furnace, as each burner will burn only the amount of gas for which there is air available in its particular position in the furnace.

orifices, drilled to suit the pressure used, which are normally open and the small quantity of gas leaking off is bled to the furnace.

Arrangement of valves and equipment is shown by the headpiece. A minimum fire adjustment is provided on each gas valve and the minimum boiler load which can be carried with all burners in operation depends upon these settings. If a lower load than this is necessary, individual burners may be shut off manually without interfering with the operation of the control as each burner is independent.

By substituting electric contacts for leak-off ports on the proportioning device, and a motor operated gas valve for the diaphragm type a complete electrically operated system results. As shown on Fig. 1, the damper is operated by motor drive but a hydraulically operated regulator may be substituted if desired. In that case the MJL Regulator No. 27 made by Morey & Jones, Ltd., is used.

Forced Draft

When forced draft is used the function of the Motor Modulator is extended to include the forced draft damper as well as the uptake damper, a typical installation being shown by Fig. 4. This is one of a number of boilers, each fired by several forced draft burners, the rest being omitted for simplicity. As before, the Motor Modulator acts as a master regulator moving the dampers of all boilers in unison, and as the modulator contacts are of the mercoid type they will handle currents sufficient to operate any size damper motor required by the particular installation. The Bourdon spring in the modulator may be supplied for any pressure up to 3000 lb. in approximately 50 lb. steps. Both the normal pressure and the pressure differential, or, pressure variation between full and no load, may be changed by simple lever adjustment as mentioned in Fig. 2. This differential is adjustable over a range from 1 to 20 lb. plus or minus from normal.

In the forced draft installation as shown by Fig. 2 (Series 15FD) the vane type proportioner, Fig. 3, is replaced by a diaphragm type shown in cross section by Fig. 5. A limiting device is also added to break the damper motor circuit and prevent movement of the damper while the gas valves operating pressures are unbalanced. This prevents over travel of the gas valve and also prevents further movement of the dampers should the gas valve stick.

Operation of the various parts are described in detail by Fig. 5. The gas flow to the furnace is propor-

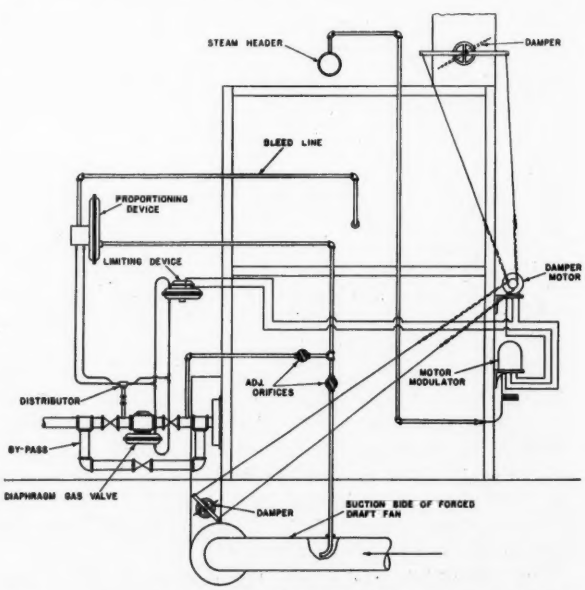


Fig. 4. Arrangement of Weco Control (Series 15FD) for forced draft. The same motor modulator is used as for natural draft (Fig. 1), but a diaphragm type proportioner is substituted for the vane type. A diagrammatic arrangement of the equipment is shown by Fig. 5. This proportioning device may also be used for natural draft by changing the draft tube connection as indicated by Fig. 5

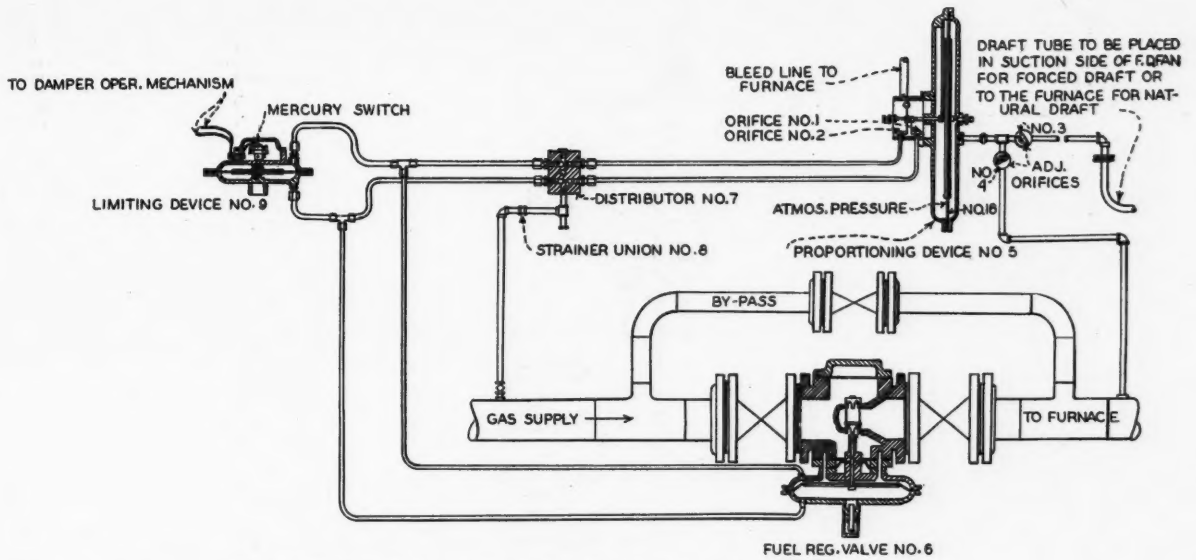


Fig. 5. Diagrammatic arrangement of equipment as shown by Fig. 4 for forced draft

Operation is as follows: On an increase in steam load there is a drop due in steam pressure and the damper mechanism (see Fig. 2) starts opening the damper in the forced draft air duct and in the stack so as to increase the air flow to the furnaces. This increases the suction on the fan inlet or draft tube, which in turn through adjustable orifice 3, increases the suction on diaphragm 16 of proportioning device 5. Movement of this diaphragm closes orifice 1 and, through the action of distributor 7, builds up pressure on the lower side of the diaphragm of fuel regulating valve 6, causing it to start to open.

This valve will continue to open until the increased gas flow through it builds up a sufficient flow of gas through orifice 4 to balance the fan suction at atmospheric pressure. This allows diaphragm 16 to return to normal and again open orifice 1. Opening of orifice 1 equalizes the pressure on the upper and lower sides of the diaphragm of the fuel regulating valve 6 and holds the valve in this position until there is a further change in furnace draft due either to changing load or changing atmospheric conditions. With an increase in steam pressure due to a drop in load the draft is decreased by the damper mechanism and the reverse action takes place, closing orifice 2 and the fuel regulating valve 6.

The limiting device 9 is connected in series with the damper mechanism and its purpose is to prevent opening or closing of the damper while the fuel regulating valve is adjusting itself to conform with the draft condition in the furnace. Whenever there is a difference in pressures between the upper and lower sides of the diaphragm of the fuel regulating valve there is the same difference in pressures between the upper and lower sides of the diaphragm of the limiting device.

Any pressure differential between the upper and lower sides of the limiting device diaphragm operates a mercury switch breaking the electrical circuit of the damper mechanism and the damper will not be moved while the pressure regulating valve 6 is opening or closing. When the air-gas ratio has been corrected by the fuel regulating valve to conform with the draft condition in the furance, the valve stops its movement, due to equalization of pressures on both sides of the diaphragm. At the same time pressures are equalized on both sides of the limiting device diaphragm closing the mercury switch and allowing damper mechanism to operate if the steam pressure changes.

Adjustment for CO_2 is as follows: To increase the CO_2 the size of orifice 4 is decreased. This restricts the flow of gas from the downstream side of the gas valve to the draft tube. Hence, for a given furnace draft, orifice 1 will be closed by diaphragm 16 because gas is flowing out of orifice 3 faster than it is flowing into furnace side of diaphragm through orifice 4. This allows the fuel regulating valve to open a little wider with a given furnace draft and gives a higher CO_2. To decrease the CO_2 the size of orifice 4 is increased.

tional to the square root of the differential between the gas pressure preceding the burner and the furnace pressure, while the air flow is proportioned to the suction in the forced draft suction pipe, i.e., the differential oetween the suction pressure and atmosphere. Inasmuch as the atmospheric pressure is practically constant and fluctuations in furnace pressure small due to the combined damper operation, gas pressure ahead of the burner is taken as a measure of the gas flow and the suction at the forced draft fan is taken as a measure of the gas flow. These two valves, one a pressure, the other a suction, are balanced against each other on one side of the proportioner as shown and the gas-air ratio is set by proper adjustment of two adjustable orifices, indicated as Nos. 3 and 4 of Fig. 5.

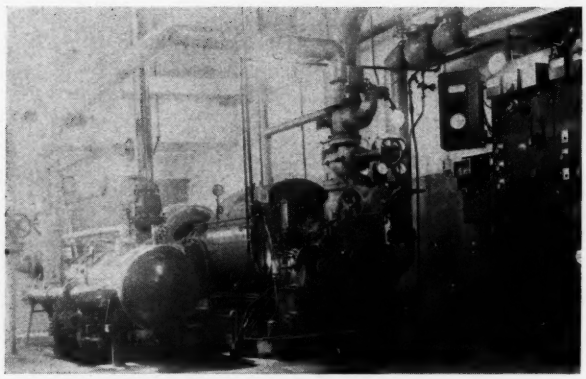
One side of the proportioning device diaphragm is open to the atmosphere. The small inward flow of air through the leak-off valve chamber carries the bleed gas through the bleed line to the furnace. The other side of the proportioning device diaphragm is subjected to the combined gas pressure and fan suction. When these two are proportional, as set by the adjustable orifices, they balance each other at atmospheric pressure. In this case the diaphragm and connected leak-off valves are in neutral position and operating pressure on both sides of the gas valve diaphragm equal.

A change in steam load is reflected by movement of the dampers and a changed air flow to the furnace. This unbalances the proportioning device which then operates to change the gas flow and maintain the predetermined gas-air ratio. Detailed explanation of the operation is explained in connection with Fig. 5. The limiting device No. 9 is a mercoid switch which operates to break the damper motor circuit when the gas valve operating pressure is unbalanced either direction. In this way, change in position of the dampers, while the gas valve is opening or closing, is prevented.

In a recent ruling, the Federal Trade Commission stated "The words 'air conditioning' signify the control, by a mechanical device, of the temperature, humidity and circulation of the air in rooms, buildings and railroad passenger trains; and the non-performance of any one or more of these functions takes the device out of the class of air conditioners, according to the understanding of the trade and the purchasing public. The wording of this definition should make it applicable to systems installed as well as to equipment, appliances and devices. Its protection to the purchaser, in this phase of air conditioning, is equally desirable at the present time."

Packing Plant Adds to Capacity

G. M. Peet Packing Co. Installs New Boiler, Turbine and Engine-Driven Refrigeration Units to Take Care of Increased Demand for Farmer Peet's Pride Products



The surface condenser installed alongside the turbine simplifies construction for the small plant.

SMALL PLANTS, often handicapped by lack of space, hesitate to add generating equipment because the difficulty of balancing steam and electric loads makes a condenser advisable and a condenser in the conventional position underneath the turbine means excavation or increased building headroom.

For this reason the new power plant of the G. M. Peet Packing Co. at Chesaning, Mich., is of unusual interest. As shown by Fig. 1, the condenser is installed alongside the turbine making a simple and inexpensive arrangement that should have widespread industrial application. In fact this arrangement has been seriously mentioned as a possible method of reducing central station costs. In this plant the boiler has been installed without excavation, the concrete floor serving as the ash pit floor with the stoker grates set about 3 ft. higher.

The new boiler is a Murray 150 hp., 300 lb., straight tube type fired by a Detroit stoker and equipped with Yarway blowoff valves, Hays CO_2 recorder, Cochrane steam flow meter, Ruggles-Klingemann step action regulator, Reliance gage column and a Copes feedwater regulator. Feedwater is heated in a Hoppes heater located in the adjacent turbine room.

As shown by the photograph, the new turbine is a 222 hp., 4469 r.p.m., 240 lb., 50 deg. superheat Murray turbine geared to an Ideal 150 kw., 1200 r.p.m., 210 v., 3 ph., 60 cycle generator with a direct connected exciter. The turbine bleeds at 60 lb. and exhausts to a C. H. Wheeler surface condenser, connected to the side of the turbine as shown by means of a Badger copper expansion joint. The unit is equipped with a Foster atmospheric relief valve, visible just to the left of the generator in Fig. 1. A single stage steam ejector located below the gage at the far end of the condenser discharges to the free side of the relief valve. Circulating water is supplied from the river by the general service pumps for the plant. The Wheeler motor driven condensate pump is located in an adjacent room at a lower level. The hotwell is equipped with a Yarway water column and Reliance pressure switch which signals high water by means of lights and a siren.

The control board is an Ideal with Roller-Smith instruments, synchroscope and circuit breakers, a Sangamon watthour meter and a Simplex voltage regulator. An older 150 kw. Westinghouse turbine unit for non-condensing operation is maintained for standby service. At the same time the power plant was built the company added several new freezers. The refrigeration load is carried by two York motor driven compressors and a new 8 by 8 in. Frick vertical duplex compressor driven by a Troy Engberg steam engine.

The engineering work both in the power plant and packing plant was done by Brady, McGilvery & Malloy of Chicago.

Alloys for Engines

STEAM ENGINE MANUFACTURERS, especially those interested in small units for auxiliary drive where space and weight requirements are at a premium, have not been slow to take advantage of new and better steels as they are developed. Typical design makes extensive use of nickel and alloy steels and modern roller bearings. A high test nickel alloy cast-iron is suitable for such parts as cylinders, heads, pistons and valve liners, and, steel castings, containing about 1½ per cent nickel and 0.25 per cent carbon, for cross heads. If this latter casting before machining, is quenched in water at 1550 deg. F. and tempered at 800 deg. F., the result is a yield point of 70,000 lb. per sq. in. and elongation of 22 per cent or over.

These properties permit lighter weight design than is possible with a cast steel cross head, a point of considerable importance in reciprocating parts and in places where the part is alternately subjected to tension and compression with sudden load reversals. Connecting rods may be of dropped forged steel, for instance from S.A.E. 3130 nickel-chromium steel, heat treated to develop a strength of 125,000 hp. per sq. in. Piston rod may be of S.A.E. 4615 nickel-molybdenum steel, case hardened and ground. Final heat treatment in this case develops a hardness of 62/63 Rockwell C, tensile strength of about 120,000 lb. per sq. in., with a yield point of 90,000, elongation of 28 per cent in 2 in. and reduction in area of 65 per cent.

Part XII

Neutralizing Electron Tube Amplifier circuits

ELECTRON TUBES — Principles and Applications

By A. W. KRAMER

SO far in this discussion, tubes with only two and three elements have been considered. As pointed out in the introductory articles, however, other elements may be added to the structure to enable the tube to fulfill certain specialized functions and applications. Also, two or more sets of elements may be combined in one bulb so that a single tube may be used to perform two or three separate functions. A simple example of the latter principle is the double anode rectifier, shown in Fig. 1, which, with a single tube, permits full wave rectification as explained in an earlier chapter.[1] Tubes with more than three elements are called multi-element tubes; specifically, tubes with four elements are known as tetrodes, those with five elements, pentodes. Many element combinations and structures become possible as the number of eletrodes is increased, but such tubes, thus far, have had little application outside of the radio field.

Of the possible four-element arrangements, one of the most important and one that is in wide general use is the screen grid tube.

In the preceding article in the discussion of the oscillating properties of the tube, it was shown that sustained oscillations could be generated through the return of energy from the plate to the grid by virtue of the electrostatic capacity existing between the plate and grid in a circuit such as that shown in Fig. 2.

Effect of Grid-Plate Capacity of Tube on Amplifier Operation

This circuit, however, it will be noted, is the same circuit that would be used in an amplifier, that is in a circuit which was intended to amplify, but not oscillate at radio frequencies. The input and output circuits must be "tuned" to the same frequency. At low frequencies this involves no difficulties, but at high frequencies the grid-plate capacity effect of the triode becomes so large that it serves as an effective coupling between the two sides of the circuit and as a consequence so much energy is returned to the grid circuit that it is impossible to prevent the tube from oscillating. Because of this, a triode cannot be used as an amplifier at high frequencies unless special circuits are employed. When the amplifier is designed to operate over a relatively small frequency range such special circuits are satisfactory, but where a considerable fre-

[1]Part III. Page 233, April 1936 issue.

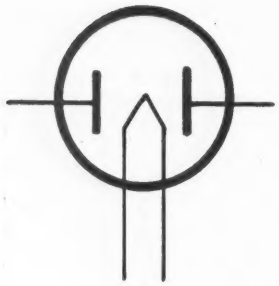


Fig. 1. The double diode. By means of a single cathode and two plates all mounted within a single bulb the functions of two tubes are combined into one

quency range is involved they possess certain shortcomings.

It is with respect to this phase of amplifier operation that the screen grid tube has advantages. The screen grid tube is nothing more than a triode with an additional grid introduced between the control grid and the plate. This second grid forms an electrostatic shield which reduces or neutralizes the grid-plate capacity of the tube and thus prevents the return of energy to the grid circuit; hence it prevents oscillation.

Neutralization

Before the details of screen grid tube operation are considered, however, it will be of interest to discuss briefly the special circuits mentioned above. For the function of these circuits is very much like that of the screen grid, i.e., to neutralize the capacity of the tube. And here, again, as in the case of resistance[2] when we speak of neutralizing the capacity we mean neutralizing the capacity *effect*. The process of neutralization really involves the taking of some of the radio frequency voltage from the output or input circuit of the amplifier and introducing it into the other circuit in such a way that it effectively "bucks" the voltage operating through the capacity of the tube, thus rendering it impossible for the tube to supply its own excitation. For complete neutralization, it is necessary, therefore, that the neutralizing voltage be opposite in phase to the voltage through the grid plate capacity of the tube and equal to it in value.

There are a number of ways in which this neutralization can be effected. All of them involve some sort of electrical "network" or bridge circuit which transfers energy in a direction opposite to that through the grid-plate capacity of the tube. The out-of-phase voltage required in the neutralizing process can be obtained quite readily by using a balanced resonant circuit in either grid or plate and taking the neutralizing voltage from the end of the tank opposite to that to which the grid or plate is connected. Such an arrangement is shown in Fig. 3. The lower end of the tank[3] coil, it will be noted, is connected to the grid through a variable condenser, C_N. This condenser is always a small unit since its capacity must be comparable to the grid-plate capacity of the tube. It is by means of this "neutralizing" condenser that the amplitude of the neutralizing voltage can be regulated.

[2]See Part XI, December issue, page 700.

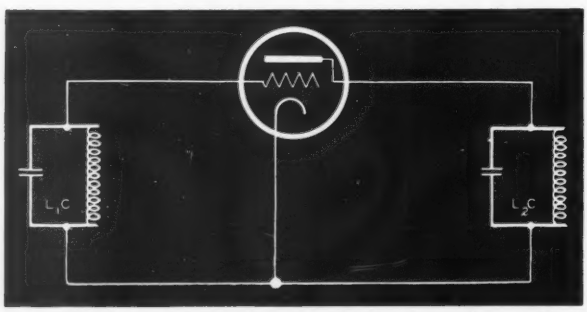


Fig. 2. Tuned-grid, tuned-plate circuit. The limitations of this circuit as an amplifier are due to the fact that the tube, by virtue of its interelectrode capacity, acts as a coupling device for the transfer of energy from the plate circuit back to the grid circuit

Types of Neutralizing Circuits

In the circuit in Fig. 3, the neutralizing voltage is obtained from the plate "tank." As implied above, however, it may equally well be taken from a grid tank as shown in Fig. 4. This circuit, it will be noted, resembles the plate neutralizing circuit of Fig. 3, except that the neutralizing voltage is obtained from a balanced input tank and fed to the plate of the tube. These two circuits represent the two general classes of neutralizing circuits, i.e., "plate neutralizing circuits" and "grid neutralizing circuits." Each have their advantages. In these circuits as shown here, the electrical network involved in the neutralizing arrangement is shown in heavy lines. As will be noted, these circuits actually form bridge circuits, the grid-plate capacity of the tube and the neutralizing condenser forming the two capacitive arms, while the halves of the balanced tank circuit form the other arms.

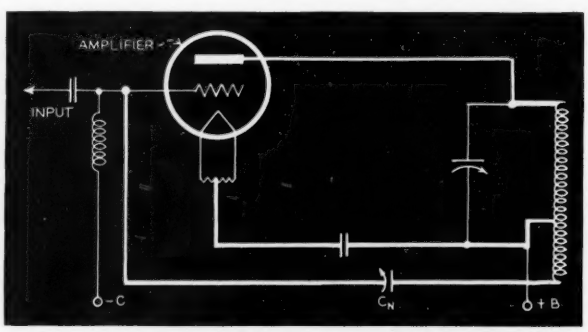


Fig. 3. Circuit showing the method used for neutralizing the capacity effect of the tube

In both of these circuits the division of radio frequency voltage between the plate and neutralizing portions of the circuit has been obtained by balancing the tank coil. The balance, however, can also be capacitive by the use of a split stator variable condenser with a grounded rotor, as shown in Fig. 5.

Many other neutralizing arrangements are possible, some of which involve circuits which have not yet received consideration in this series of articles and those will be considered at the time these circuits are discussed, but in all instances the fundamental principles involved are the same. Their purpose is to produce a voltage which will oppose the voltage operating

[3]The term "tank" circuit is one which has been applied to the resonant circuit at the output end of an amplifier—usually a power amplifier, for it is in this circuit that currents of high magnitude are set up and from which the energy is drawn for whatever useful purpose may be desired. It constitutes, as it were, a tank or reservoir of high frequency electrical energy. It is always a tuned circuit.

through the grid-plate capacity of the tube, thus rendering the latter ineffective. In most cases the neutralizing voltage will be equal to the radio frequency voltage between the plate and grid of the tube so that for perfect balance the capacity required in the neutralizing condenser theoretically will be equal to the grid-plate capacity of the tube being neutralized. Thus, it is obvious that the neutralizing capacity required at C_N will depend upon the type of tube and the characteristics of the circuit. When two or more tubes are connected in parallel, the neutralizing capacity required will be in proportion to the number of tubes.

The matter of neutralizing is important only when amplifiers are operated at high frequencies such as those used in radio communication work because it is only at high frequencies that the grid-plate capacity effect of the electron tube becomes large enough to re-

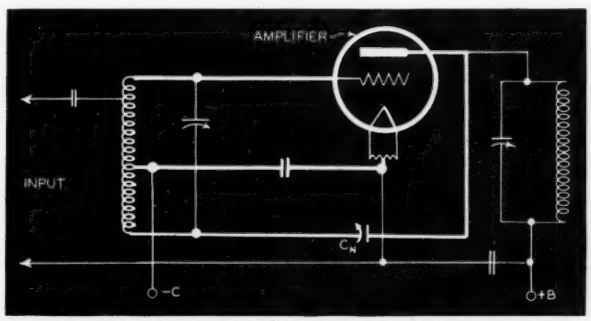


Fig. 4. In this circuit the neutralizing voltage is obtained from the grid tank instead of the plate tank, as shown in Fig. 3

sult in the transfer of energy from the plate circuit. The capacity reactance of any condenser increases with the frequency of the current. For illustration, suppose we have a condenser with a capacity of 0.1 microfarad operating at a frequency of 1000 cycles per second. The capacity reactance of the condenser at this frequency can be figured by the following formula:

$$X_c = \frac{10^6}{2\,\pi\,f\,C_{mfd}}$$

where X_c is the capacitive reactance in ohms
π is 3.1416
f is the frequency in cycles per second
C_{mfd} is the capacitance in microfarads
substituting our known values in this formula, we have

$$X_c = \frac{10^6}{6.2831 \times 1000 \times 0.1} = 1590 \text{ ohms}$$

Now, suppose we leave all conditions exactly as they are except the frequency; suppose that is changed to 1,000,000 cycles. At this frequency the capacitive reactance is

$$\frac{10^6}{6.2831 \times 1{,}000{,}000 \times 0.1} = 1.59 \text{ ohms}$$

This simple illustration will serve to show why the capacity effect of the tube elements becomes important at high frequencies. When it is realized that in the communication field, frequencies of 1 to 10 or 15 million cycles per second are common, it will be apparent that even very small condensers such as those formed

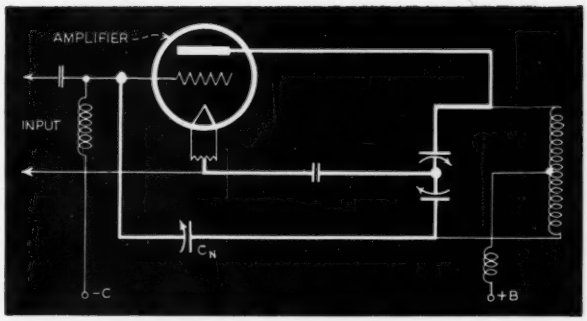


*Fig. 5. Here, the balance is capacitive and is obtained by the use of a split stator variable condenser

by tube elements present low reactance and therefore pass large currents.

In ordinary industrial applications of electron tubes, however, high frequencies are not the rule and hence, the importance of neutralization in amplifier circuits is diminished. In the case of amplifiers operating at a few thousand cycles per second the capacity of the tube is a negligible factor since at these frequencies the capacity reactance of the tube is so high as to prevent any appreciable "feed back." A proper understanding of electron tube operation, however, implies knowledge of neutralization and for this reason it has been considered in some detail here. Furthermore, it has a bearing upon the next phase of our discussion, screen grid tubes, so from that standpoint neutralization is of interest.

Method of Neutralizing

The procedure involved in neutralizing an amplifier is simple but it should be done accurately if complete neutralization is to be attained. The first essential in the process of neutralization is to have some sort of sensitive radio frequency indicator; a small neon bulb[4], a flash light lamp with its terminals connected to a loop of wire or a thermo-galvanometer connected to a wire loop.

Having such an indicator available the first step in neutralizing is to disconnect the plate voltage from the tube and to set the neutralizing condenser at zero capacity. Its cathode should be heated, however, and the excitation from the preceding stage should be fed

[4]A small ¼, ½ or 1 watt bulb such as are used as indicating lamps on 110 v. circuits will serve nicely for this purpose.

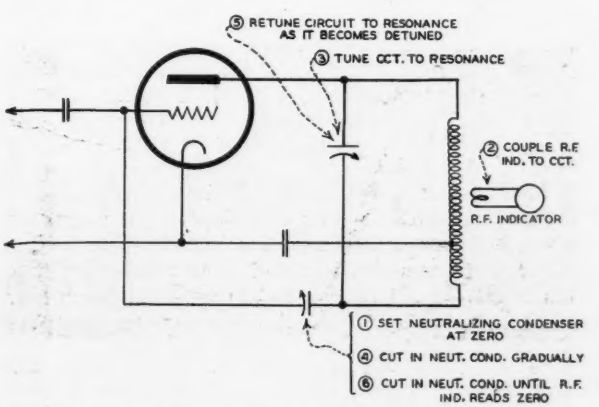

⑤ RETUNE CIRCUIT TO RESONANCE AS IT BECOMES DETUNED
③ TUNE CCT. TO RESONANCE
② COUPLE R.F IND. TO CCT.
R.F. INDICATOR
① SET NEUTRALIZING CONDENSER AT ZERO
④ CUT IN NEUT. COND. GRADUALLY
⑥ CUT IN NEUT. COND. UNTIL R.F. IND. READS ZERO

Fig. 6. Steps involved in neutralizing an amplifier

to its grid circuit. Next, the radio frequency indicator should be coupled to the plate tank circuit and the plate circuit tuned to resonance which will be indicated by a maximum reading or indication of the radio frequency indicator. If a neon bulb is used as an indicator merely place the metal base in contact with the plate circuit.

Now with the plate circuit still tuned to resonance and the indicator in action, gradually increase the capacity of the neutralizing condenser. This will cause the indicator to register less current. This process may throw the plate circuit slightly off resonance so it may be necessary to readjust the tuning condenser slightly so as to bring it back to resonance. Continue to turn the neutralizing condenser until, finally, a point is reached where no further indication of radio frequency current is obtained. When this point is reached the circuit is properly neutralized. These steps are indicated in Fig. 6.

As has been implied, perfect neutralization cannot be maintained over a wide band of frequencies because leakage inductances and stray capacities prevent the neutralizing current from being exactly proportional to, and exactly out of phase with the current through the grid plate capacity at all frequencies. Imperfect neutralization results in a certain amount of regeneration but ordinarily it is possible to maintain a balance which will give stable performance of a radio frequency amplifier over a range of several million cycles per second; which of course is sufficient for most ordinary purposes.

Air-Minded Seattle

ONE OF THE LARGEST unobstructed working areas ever provided for industry was recently completed for the Boeing Aircraft Co. at Boeing Field, Seattle, Wash., in one room 204 ft. by 304 ft., which rises to a clear height of 35 ft. to make 2,100,000 cu. ft. of unobstructed space available. The building affords finished bombers access to the field through a "front door" 195 ft. wide and 35 ft. high.

The sawtooth roof is equipped with electrically operated transoms extending across the width of the building. Artificial lighting for night work provides 16 ft. candles at bench height over the entire area. Brick has been used below the sill of the lower band of sash, upper areas separating the bands of sash consisting of two layers of metal sheathing separated by 1 in. of insulation and calculated to yield temperature protection equivalent to a 12-in. brick wall.

Accessibility

Motors, wings, fuselage, and other airplane parts will be handled inside the assembly shop on a monorail system suspended from the bottom chord of the long roof trusses and installed in removable units so that it can be rearranged to accommodate particular requirements at any time. A frame catwalk along the side walls just below the trusses gives access to the framing so that the monorails can be adjusted and lighting bulbs and fixtures can be easily cleaned or replaced.

In order to keep the working area entirely free of interference from overhead wiring and pipes and at the same time maintain maximum accessibility of service facilities, The Austin Co., which designed and erected the plant, placed all electric, water, gas, steam and compressed air lines in concrete tunnels underground. A 425 ft. main tunnel, 6 ft. wide and 7 ft. high, extends from the boiler house 50 ft. away to the southwest corner of the assembly plant, and then the full length of the structure just outside the building line, where the top of the tunnel would serve as part of the floor in any extension to the south.

Six tributary tunnels lead under the assembly floor, where steel framed manholes at 40 ft. centers across the building give access to sub-distribution electric panels for connecting electric tools and special lighting, or for making water, air and gas connections.

Power House

The power house for the plant is distinctive with its outstandingly modern electrical installations. All switches, oil circuit breakers, disconnect switches, bus bars, instrument transformers, watt-hour meters and a graphic recording watt-meter are enclosed in a single "dead front switchboard" cabinet. When doors to the cabinet are opened, automatic limit switches cause the oil circuit breakers to open, thus killing the current in all exposed conductors. There are five Pyranol transformers, supplying 440-v. 3-phase for power and 208-v. 3-phase, and 120-v., single-phase for lighting circuits.

Heat for the plant is supplied by a 250-hp. steam boiler and the heat distribution is handled through unit heaters along the side walls and on the bottom chords of the roof trusses. Notwithstanding its size, the plant can be brought up to working temperature in an hour's time in extreme cold weather. The plant is protected by a complete automatic sprinkler system, including a 150,000 gal. emergency sprinkler tank which can be used in the event of failure of the city water supply.

J. M. Frank, President of the National Association of Fan Manufacturers, in his report to be submitted at the Annual Meeting, indicated that the Standard Test Code for Disc and Propeller Fans, Centrifugal Fans and Blowers was one of the contributing factors in helping to establish standards for the Air Conditioning field. He pointed out that the fan or blower is the "heart" of any air handling system whether for heating, ventilating, air conditioning or conveying materials. The Engineering Committee of the Association has carried on considerable research for the purpose of checking all theories with actual practice. As a result of this painstaking care, there has been wide acceptance of the Standard Test Code for Fans by architects, engineers, engineering societies, governmental departments, such as the Navy, the Army, and Agriculture, as well as the recognition afforded by the Federal Trade Commission that the ratings of fans is a matter of public interest and therefore reasonable protection should be afforded the buyer against erroneous rating.

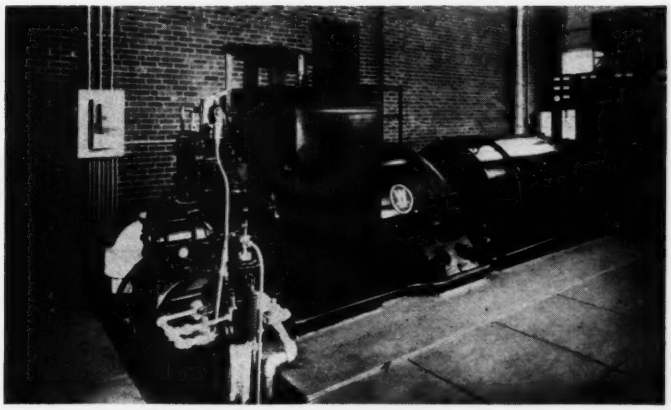


Fig. 1. One of the two 1250 kw. turbine generators that produce power for the sewage disposal plant in Providence, R. I.

GARBAGE Used As FUEL in 1250 kw. Electric Plant

THE NEW PROVIDENCE, R. I., incinerator plant with waste heat boilers to produce electric power for the city's sewage plant, is the result of a two years' investigation supervised by Charles A. Maguire, Commissioner of Public Works and Philip J. Holton, Jr., Mechanical Engineer. The studies were based on redesigning the existing incinerator for use with waste heat boilers and turbo-generators, but tests proved that the existing incinerators could not be used for power purposes, so a complete new incinerator with waste heat boilers and turbo-generators was built adjacent to the sewage disposal plant to which the electric power is delivered.

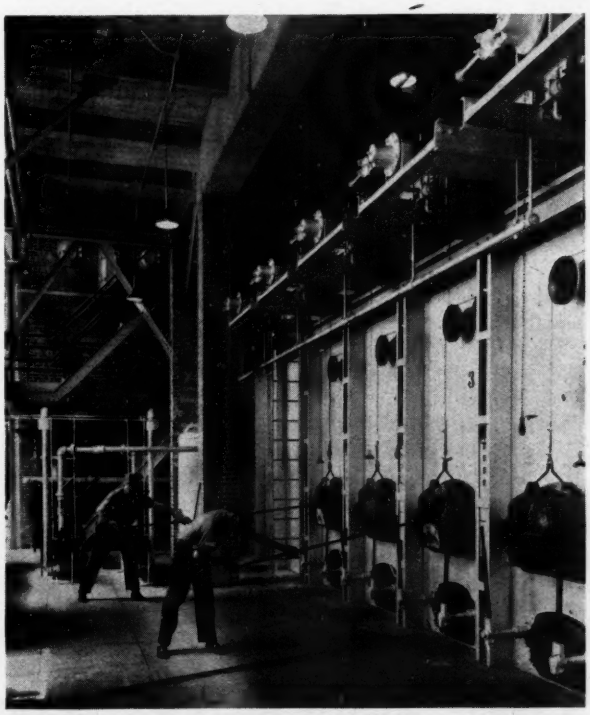


Fig. 2. Stoking the 5-cell furnace. Pneumatically operated gates meter refuse.

The plant contains a 5-cell incinerator built by the Hiler Engineering and Construction Co. of Pittsburgh, having a capacity of 160 tons of refuse per 24 hr., and an overload capacity of 200 tons per 24 hr. Trucks discharge the refuse into a large storage bin from which the incinerator hoppers are charged periodically by means of an electric crane. Air for combustion under the grates is supplied by a turbine driven forced draft fan.

Two boilers are installed, one operating and one spare. These are Babcock & Wilcox units, having a capacity of 700 hp. and are designed to generate steam at 200 lb. pressure and 100 deg. superheat. The gases from the incinerator have a temperature of 1450 deg and may be delivered to either of the two boilers.

Steam from these boilers is delivered to two 1250 kw. Westinghouse turbine generators. The plant is located adjacent to the sewage disposal plant which requires a load of about 750 kw. Approximately 1500 ft. away is the sewage pumping station, which is now operated by steam engine driven pumps about 40 yr. old. Plans call for the motorization of the station and when this work is completed, sufficient power will be available from the incinerator plant for operating the station.

The new plant was planned and built by the Hiler Engineering and Construction Company; turbines and electrical equipment were designed by Westinghouse Electric and Mfg. Co. Of brick and steel, architectural features give a pleasing appearance to the exterior. The new plant meets three requirements of the city: 1. The necessary disposal of garbage. 2. The generation of power to meet the demands of the new activated sludge process. 3. The furnishing of the necessary power to operate the pumping station after the completion of the motorization program.

Self-Regulated Compounded Rectifiers

A mercury-vapor rectifier can function as its own automatic regulator with the aid of the grid control circuit described in this paper. The control equipment is practically inertialess and, therefore, is almost instantaneous in its operation. The circuit may be compounded to have a wide variety of characteristics.

An abstract of a paper presented before the A.I.E.E.

by

W. Melvin Goodhue
and R. Burton Power

AMONG THE PAPERS presented at the winter meeting of the American Institute of Electrical Engineers held in New York last month, one of unusual interest was one by W. Melvin Goodhue and R. Burton Power, describing a new method of operating mercury arc rectifiers. By means of a grid control circuit the authors of the paper, both of Havard University, showed that a power rectifier can act as *its own automatic regulator* without the assistance of a vibrating contact. At the same time, the circuit may be compounded with respect to load current and input voltage, giving a wide variety of characteristics, ranging from cumulative compound to constant current.

Since a device incorporating these characteristics is of distinct interest to engineers concerned with the generation and use of electric power, the salient features of this paper are presented here.

The characteristics of this rectifier cover a wider range than do those easily obtained from d.c. generators. Furthermore, the automatic control is nearly instantaneous, which is certainly not true of d.c. generator equipment or vibrating and thermal types of regulators. Compared with electronic regulators, the simplest of the circuits has the advantage of not employing auxiliary tubes, which will greatly lower the cost of small installations. For example, a 3-tube rectifier employing grid-controlled gas-filled tubes, with electronic regulator, might employ 6 tubes; but in the new circuit only the 3 main power tubes themselves are necessary.

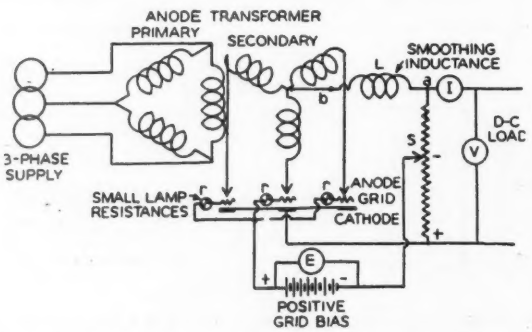


Fig. 1. Simple self-regulated rectifier without compensation.

In order that the new circuit may be readily understood, several steps in its evolution are described. In the first step, the usual alternating voltage is not applied to the grid, because the definite phase angle introduced by such an a.c. wave would destroy the sensitivity of the new self-regulating circuit. Instead, the various grids, each with its own series resistance, are connected together and to a common grid-voltage source of such a nature as to adjust automatically the phase angle at which the grids operate to fulfill the needs of the load. In this discussion, the use of a common cathode or cathode connection is assumed.

The circuit for step 1 is shown in Fig. 1. The power rectifier shown is a 3-anode polyphase rectifier, but a 2-anode single-phase rectifier also has been used. The grid resistors r consisted of small tungsten 110-v. lamps, which are convenient when the best value of resistance is to be determined by trial. The common grid source consists of a potentiometer S across the d.c. load, together with a source of positive d.c. grid bias, represented on the diagram by the battery E and usually about 90 v.

The smoothing inductance L *must* be connected to the anode transformer neutral. If accidentally connected in the cathode lead, the alternating voltage across the inductance would appear in the grid circuit with serious consequences. If connection a is moved to point b to include the inductance L, the control potentiometer S would not receive the benefit of the inductance, with poor results in the grid circuit.

A simplified picture of operation of the common grid source may now be given, assuming that the inductance L so smooths the output that no compensation for ripple in the load voltage across S need be

made. It will be assumed that an anode has just "fired," as a result of the grid reaching its critical voltage e_g, which is small in comparison with the various sources of grid voltage. The resulting power impulse causes the current in L and consequently the load voltage V to rise slightly. The voltage V, acting through the potentiometer S, therefore, decreases the total grid voltage. The relation may be expressed thus:

$$\text{Total grid voltage} = E - aV \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad 1$$

where E is the positive grid bias

a is a fraction determined by the setting of the potentiometer S

The decrease in grid voltage, below the initial or critical value, will prevent the next anode from "firing" until the load voltage V has fallen to the initial value. Hence, the next anode automatically selects a phase angle of "firing" that will maintain this initial voltage V at which the grid voltage becomes equal to the critical voltage. This is clearly a regulator action, with variable phase angle. Hence, approximately,

$$V = \frac{E - e_g}{a} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad 2$$

where

e_g is the critical grid voltage

a is the setting of potentiometer S

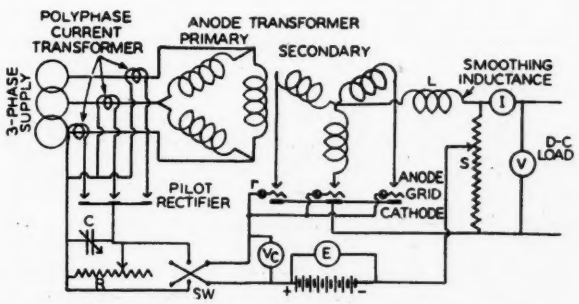


Fig. 2. Self-regulated rectifier with current compounding.

Therefore, if E be large enough to mask any variations in e_g, the output voltage V will be approximately constant, even if the voltage of the power source should vary. This result is shown in Fig. 3, which is a curve, determined exerimentally under load conditions, of output voltage as a function of input voltage. The variation in output voltage is actually too small to read on an accurate portable voltmeter, even for very large variations in input voltage. The equipment employed was compensated by the compounding method described later in the paper. Without compensation, a variation of output from 184 to 185 volts occurred for a variation of input from 127 to 163 volts.

If the variation of input voltage occurs suddenly the results are even more startling. With an alternator for power source, a pure resistance load was connected across the alternator terminals, in parallel with the rectifier input, by closing a switch. The rectifier output voltmeter showed no flicker of its pointer or change of reading either at the start, during the transient, or after the transient. In spite of this, a voltmeter across the input showed that the sudden impulse was followed by a steady drop in input voltage of 20 or 30 per cent. A mechanical regulator cannot thus

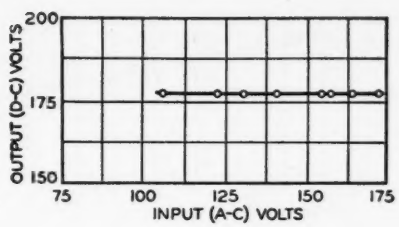


Fig. 3. Constancy of output voltage with variation of input voltage Rectifier completely compensated against load and input voltage.

exceed the response speed of voltmeters because of the inertia of the mechanism.

When the load current is varied, however, changes occur which prevent the output voltage from being perfectly constant. The question of compensating these changes and the more general application of the circuit suggest compounding, which is the second step in the development of the regulator.

Compounding

Compounding is accomplished by introducing other d.c. automatic control voltages into the common grid circuit. It will be desired, therefore, to have a d.c. automatic-control voltage that is proportional to the load current.

For the purpose of discussion, the anode power transformer will be assumed to be unsaturated. This assumption is probably untrue, but serves as a convenient introduction. It follows, from the laws of transformers, that the input (alternating) current is nearly proportional to the load (direct) current, although its phase angle is variable and its wave shape slightly variable. The problem reduces to that of obtaining a d.c. voltage proportional to the input current. For this purpose a polyphase current transformer is inserted, as shown in Fig. 2, operating a pilot rectifier, which in turn is loaded by the rheostat R. The voltage output across this rheostat is proportional to the load current and the resistance of the rheostat, and inversely proportional to the ratio of the current transformer. It is connected into the common grid circuit through the polarity reverse switch SW, which makes possible both positive and negative compounding, the latter having

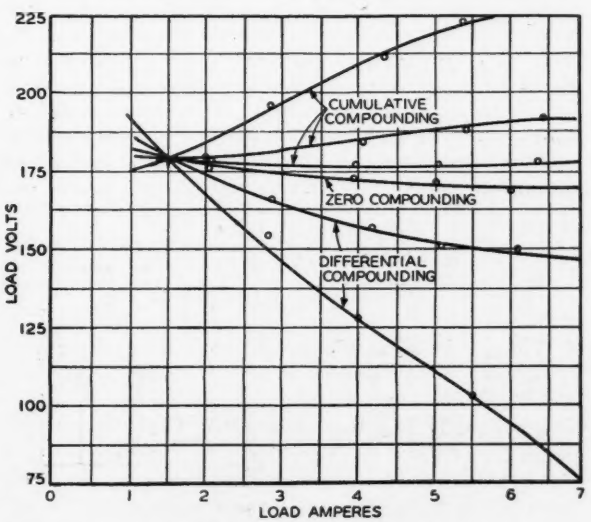


Fig. 4. Effect of current compounding, with different settings of grid-control rheostats; input voltage constant.

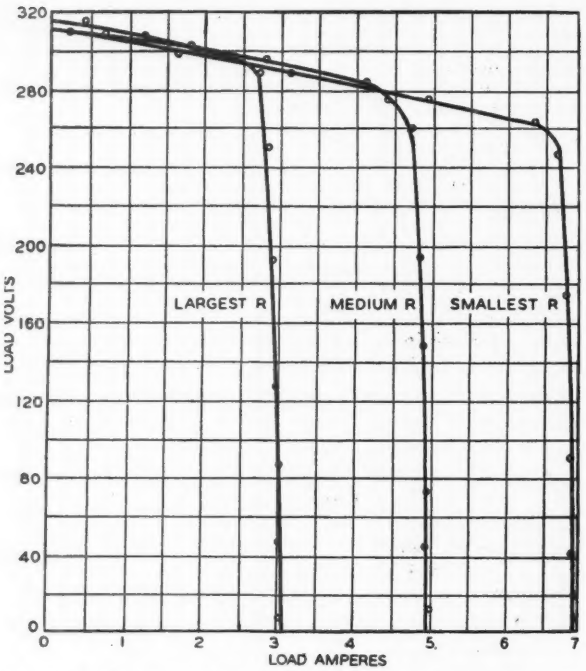


Fig. 5. Constant current output with varying load voltage, for 3 settings of rheostat in grid circuit; load voltage potentiometer set at zero.

as many applications as will be shown later as the former. Polarity reversal may be obtained smoothly by using a potentiometer instead of rheostat R, and connecting the grid circuit to contact and to center of potentiometer. The capacitance C, determined by trial, is sometimes unnecessary. The maximum value required in these experiments was 13 microfarads, which should be variable in 1-microfarad steps. The tubes employed must be reliable, lest erratic results be obtained. About 10 per cent over-compounding was found to be sensitive to this. Knowledge of reliability is obtained only by substituting tubes.

Results of the compounding in Fig. 2 are shown in Fig. 4, for different settings of the rheostat R, which controls the slope of the curve. The height of the curve as a whole is determined as before by potentiometer S. In equation form:

$$e_g = \text{total grid voltage} = E - aV = B\,I \quad \ldots\ldots 3$$

where

a is proportional to the setting of potentiometer S

B is approximately proportional to the setting of rheostat R

or

$$V = \frac{E \pm B\,I - e_g}{a} \quad \ldots\ldots 4$$

The departure of the curves from the straight lines of equation 4 may be seen to follow almost exactly the departure of the zero-compounding curve (B = O) which already has been discussed. Cumulative compounding of slope at any point greater than that of a straight line drawn through the origin to the same point is not to be desired. This is because any device with such slope would not have stable operation at that point, even with pure resistance load, for the output voltage would rise faster (greater slope) than the voltage of the pure resistance load. Using pure resistance load, it was found that as the slope approached that of a resistance line, operation soon became unstable. Probably a special laboratory load, connected in series with a d.c. constant-current circuit, could permit measurements in such unusual regions, but such characteristics do not seem to have any practical applications. It might be mentioned that because of saturation the ordinary series-wound d.c. generator, which represents the limit of compounding of a compound-wound generator, has less slope than any resistance line. As is well known, d.c. generators having straight-line saturation curves are unstable unless separately excited, or else regulated.

Thus, it may be concluded that the compounding of a self-regulated rectifier is limited chiefly by those circuit considerations that apply to all d.c. sources. It might be interesting to test the limit of differential compounding. For this limit, a = 0, in order to raise the height of the hypothetical open-circuit voltage to infinity. Then in equation 4,

$$V = \frac{E \pm B\,I - e_g}{0} \quad \ldots\ldots 5$$

where V is limited to finite voltages, and particularly to the maximum voltage the rectifier can generate. Therefore, the numerator of equation 5 must be zero and

$$\pm B\,I = e_g - E \quad \ldots\ldots 6$$

But I is positive only, in a properly designed rectifier, so that operation is possible only with the minus sign, or in the differential-compounding direction. Finally,

$$B\,I = E - e_g \quad \ldots\ldots 7$$

The value of I is dependent on e_g which is negligible, E which is constant, and B which depends on the setting of resistance R of Fig. 2. Therefore, I is nearly a constant current, independent of load voltage or input voltage.

The experimental results obtained with these adjustments are shown in Fig. 5. The 3 curves are for 3 settings of the rheostat R which controls the current. Up to the working voltage of 180 v., or even up to 220 v., the output current may be seen to be nearly constant. The slight decrease in the current shown in each characteristic as load voltage is increased to 180 volts, corresponds to the high light-load voltages of Fig. 4. For example, in equation 7, an increase of load voltage makes the phase angle of grid firing less lagging, giving less forward voltage, and more positive e_g. Because of the minus sign of e_g, I is reduced.

The top portions in Fig. 5 are interesting because when the supply voltages to the anodes are insufficient for the load voltage, regulation must cease and the curves flatten out as shown. Each curve then consists of a constant-current portion and a nearly constant-potential portion, smoothly joined by a rounded knee, as in magnetic saturation curves. The practical applications of such a characteristic are, therefore, multifold. Not only may constant direct current be obtained from alternating current at constant potential, but both parts of the characteristic might be used

in the same application. For example, if the armature of a separately excited d.c. motor be connected as load, then during the starting period the current and hence torque will be constant, which is desirable economically and mechanically. When the motor reaches the operating speed, its back electromotive force (the load voltage) reaches the constant-potential portion of the characteristic and the speed becomes nearly constant. It may be noted that there are no steps in the starting characteristic, nor is there any starting resistance loss. Starting equipment is eliminated, and the torque may be high because normal d.c. motors may be used at voltages to which they are best adapted. Speed is controlled as usual by the motor field, which can be supplied from the same a.c. source by a small grid-controlled rectifier, eliminating field rheostats, and giving "vest pocket" or even photo-electric-cell control. The maximum permissible transient-load torque is equal to the starting torque, which may be set by the operator by means of the rheostat R, as is usual, at some value between 100 and 300 per cent, for example. At any time, the starting current can be reduced below the maximum permissible value by inserting a resistance in the grid-control rheostat R during starting only. As a machine that has been started can be operated with entirely different characteristics (as flat, drooping, or rising speed-torque characteristics), the possibilities are rather numerous and attractive.

(Ed. Note: The method of obtaining "Potential Compounding" with this equipment will be discussed in a subsequent article.)

Depreciation Reserves

BECAUSE of the changed situation due to the tax of from 7 to 27 per cent on undistributed surplus, adequate allowance for depreciation becomes of vital importance, as pointed out in the report of a committee of the Machinery and Allied Products Institute. Unless proper depreciation is allowed for, not only is the normal income tax higher than it should be, but, with high dividend disbursements, capital will be impaired, since funds will not have been provided to cover depreciation and to provide for eventual replacement of machinery.

Present federal tax policy tends to decrease allowance for depreciation and to insist on justification of such allowance by the taxpayer, hence adequate records are essential to prove that allowances claimed are correct.

Purposes of depreciation reserves are defined as: Maintenance of capital investment; and recovery of cost of depreciation by including it in the selling price of the product, during the useful life of the equipment.

As to methods of determining depreciation, it is pointed out that nationally standard rates are impractical, since the proper allowance will vary in each case with conditions, according to wear in use, obsolescence of equipment, obsolescence of product and method of recovery of cost. The probable useful life should be redetermined periodically to reconcile predicted life with actual life.

It is well to set up allowance for depreciation as a special reserve fund which will be available for replacement purposes at the end of the useful life of the equipment. If this is used for buying new equipment, or borrowed for working capital, books should show it, so that the amount available for replacements and its whereabouts will always be known.

In order to prove the correctness of depreciation allowance, it is well to have a plant record or ledger with a separate account for each important piece of equipment and a group account for each type of minor equipment such as small motors, shafting and pulleys, belts and the like. Each account should list the equipment covered, cost and date of installation, kind of work it does, estimated life, and periodical reëstimates of the probable useful life and of value of equipment at the time of the reëstimate. The sum of the values on these separate accounts should, of course, balance with the total equipment account, less depreciation, as shown in the general ledger and depreciation allowance should be raised or lowered to bring about such a balance.

Depreciation rates must, of course, be set up for each piece and kind of equipment but these should not be considered as invariable. They should be changed as experience shows them to be too high or too low, making sure always that the cost of equipment will be covered, at the end of its useful life, by the accumulated depreciation reserve.

New Record Set by Lamp Sales in 1936

A PRELIMINARY estimate of the number of incandescent lamps sold in the United States during 1936 indicates a total of more than 880,000,000, an increase of 19 per cent over the previous high total of 1935, according to a review of the electrical industry prepared by John Liston of the General Electric Co. The figure for large lamps is 460,000,000, and for miniature lamps is 420,000,000.

Among outstanding developments of the year in lighting equipment, Mr. Liston points out in his review, was the introduction of two screens or grids within a new 1000-watt general-service lamp to collect much of the blackening that was formerly deposited on the lamp bulb. This lamp, equipped with a medium bi-post base and an inside-frosted tubular bulb, is of special heat-resisting hard glass and permits accurate focusing of the filament. Being relatively small, it makes possible the design of luminaries of materially higher efficiency and smaller size. While the new lamp is expected to prove particularly effective when used in such outdoor services as floodlighting and for airway beacons, it is also designed to provide better lighting for stores, offices, and factories.

More miles of highway were illuminated during 1936 than during the preceding five years, Mr. Liston reported. The world's longest bridge, the San Francisco-Oakland Bay Bridge, is appropriately lighted with the golden light of more than a thousand 10,000-lumen sodium luminaries. The longest sodium highway-lighting installation in the world, along the Duanesburg Road in New York State, is 17½ miles long and utilizes 390 10,000-lumen units.

Humidity and Low Temperatures

Growing importance of humidity in low temperature refrigeration prompts construction of new chart covering range from — 40 to + 50 deg. F. for all values of humidity.

By Wallace H. Martin and Earl C. Willey,

Mechanical Engineering Department,
Oregon State Agricultural College,
Corvallis, Ore.

REFRIGERATING ENGINEERS are giving increasing attention to humidity. This humidity consciousness is partly due to the emphasis placed upon humidity by the air conditioning industry and partly to the realization that many kinds of goods in storage are susceptible to humidity conditions. It is desirable to be able to estimate closely the amount of refrigeration necessary to cool air at cold storage temperatures, particularly in those cases where appreciable quantities of air are being circulated.

In cooling air from a temperature of above 32 deg. F. to a temperature below 32 deg. F. there are six heat quantities that must be considered. They are:

1. Sensible heat of the vapor between dry bulb temperature and dew point.
2. Latent heat of the vapor condensed at the dew point.
3. Sensible heat of the condensate between the dew point and 32 deg. F. if the dew point is above 32 deg. F. If the dew point is below 32 deg. F. this value does not appear.
4. Latent heat of fusion of the water frozen.
5. Sensible heat of ice and vapor between 32 deg. F. and the final temperature.
6. Sensible heat of the air.

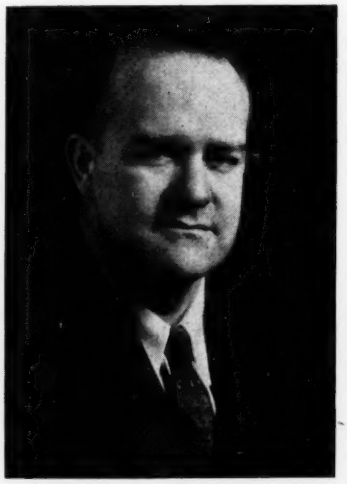
To calculate each of these values for a given condition is a laborious process. In air conditioning work the heat that must be removed can be obtained by referring to one of the many excellent charts available. However many of these charts do not give values for temperatures below 32 deg. F. and when they do the scale is such that accurate values are difficult to obtain. The accompanying chart was constructed to make possible rapid determination of the properties of air at temperatures between —40 deg. F. and +40 deg. F.

In its construction dry bulb temperatures have been plotted horizontally and heat content of mixture or humid heat vertically. Also, since many of the refrigerant tables use —40 deg. F. as a datum, it is logical to use that temperature as a datum in this case. The vapor pressure at low temperatures can be found in the U. S. Weather Bureau Psychrometric Tables and the vapor content of atmospheric air at various temperatures and humidities can be calculated in the ordinary way.

At —40 deg. F. the water vapor content per pound of saturated air at standard atmospheric temperatures is 0.000081 lb. and the latent heat is 1116.0 B.t.u. per lb. The only heat we are concerned with at this tempera-

WALLACE H. MARTIN (left) received the degree of M. E. from the University of Minnesota in 1910 and M. S. in M. E. from Iowa State College in 1930. He has held teaching positions in mechanical engineering at the University of Minnesota and at Pennsylvania State College. Since 1920 he has been Professor of Heat Engineering at Oregon State College. He is a member of the A.S.M.E., N.A.P.R.E., S.P.E.E., a registered Professional Engineer in Oregon, and a member of the honor societies Tau Peta Pi and Sigma Tau.

EARL C. WILLEY (right) received degree of B. S. in M. E. from Oregon State College in 1921 and has been teaching in the Mechanical Engineering Department at Oregon State since 1922. He is a member of A.S.H. & V.E., A.S.M.E. and S.P.E.E.



ture is the latent heat of this vapor and this is found by taking the product of these two values or 0.09 B.t.u. per lb. of air and associated vapor.

To illustrate the method used in obtaining values at these temperatures and humidities let us assume a dry bulb temperature of 40 deg. F. and a relative humidity of 0.80 per cent at 30 in. of mercury atmospheric pressure. The dew point is 34.3 deg. F. and the water vapor content per pound of air is 0.004127 lb. Since the vapor content is 0.000081 at —40 deg. F., the weight of water vapor condensed and frozen when the mixture is cooled to —40 deg. F. is 0.004127—0.000081 or 0.004046 lb. Condensation is assumed to occur at the dew point, although the actual process is of course progressive.

Sensible heat of the vapor between 40 deg. F. and 34.3 deg. F., based on a specific heat of 0.45, is $0.45 \times 5.7 \times 0.004127 = 0.0125$ B.t.u.

Latent heat of the vapor condensed at the dew point is $0.004046 \times 1074.5 = 4.3474$ B.t.u.

Sensible heat of the water between 34.3 deg. F. and 32 deg. F. is $0.004046 \times 2.3 = 0.0093$ B.t.u.

Latent heat of fusion of water frozen is $0.004046 \times 144 = 0.5826$ B.t.u.

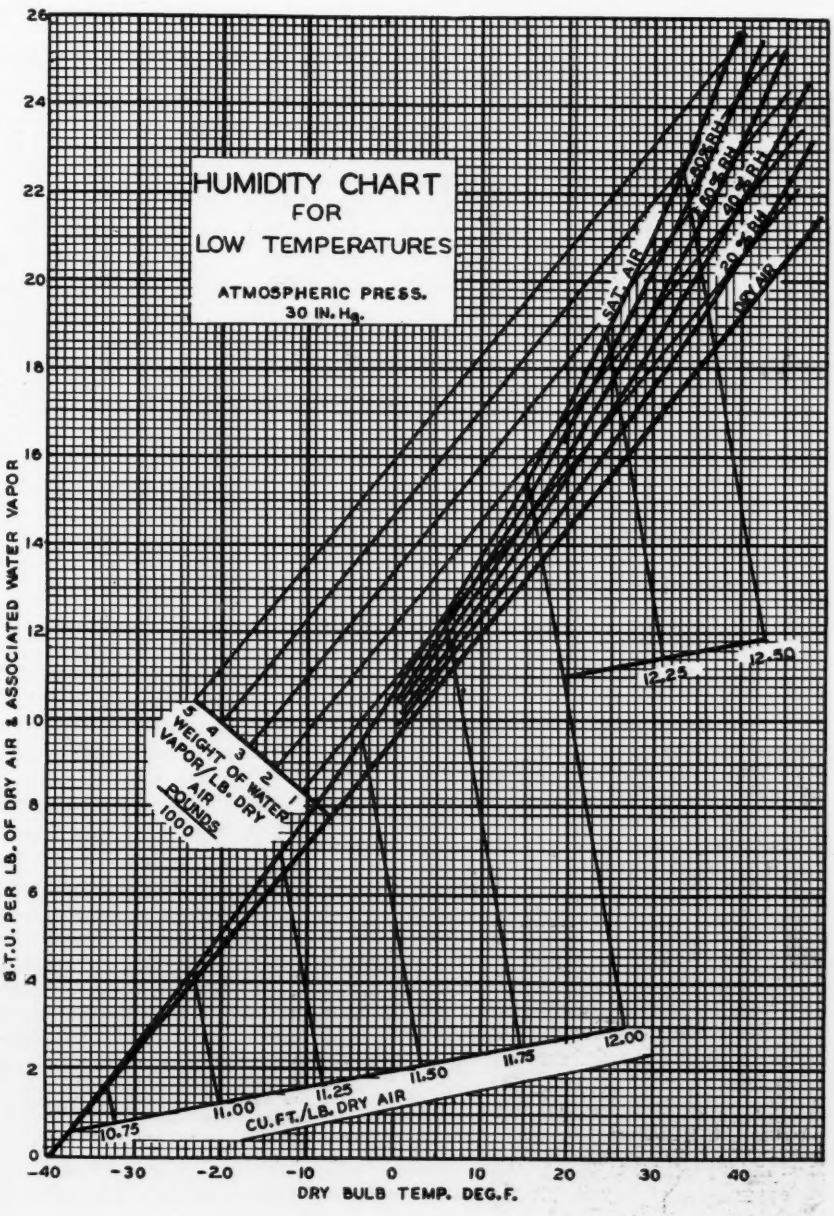
Sensible heat of ice and vapor between 32 deg F. and — 40 deg. F., based on 0.5 specific heat for each is $0.5 \times 72 \times 0.004127 = 0.1485$ B.t.u.

Sensible heat of the air is $0.24 \times 80 \times 1 = 19.2000$ B.t.u.

This gives a total of 24.3 B.t.u. per lb. of air and associated water vapor or the quantity of heat that must be removed to reduce air, which was originally at 40 deg. F. and 80 per cent relative humidity, to — 40 deg. F. Since the heat content at — 40 deg. F. is 0.09 B.t.u., the total heat content at our assumed condition is 34.3+0.09 or 34.39 B.t.u. per lb. This value is plotted vertically against + 40 deg. F. plotted horizontally and is one point on the 80 per cent relative humidity line. By calculating and plotting other points for relative humidities of 20, 40, 60, and 80 per cent and for saturated conditions the chart is obtained.

It will be observed that constant wet bulb conditions are represented by horizontal lines, constant vapor content lines by diagonal lines crossing relative humidity lines and extending upward from left to right. Constant volume conditions are represented by lines crossing the relative humidity lines in an approximately vertical direction.

Use of the chart enables one to estimate closely the amount of refrigeration necessary to lower the temperature of a given amount of air, since all heat quantities are taken into consideration and not merely the air alone. As an example: if we wish to cool one pound of air from 35 deg. F. and 80 per cent relative humidity to 20 deg. F. saturated, we obtain from the chart 22.2 — 17.1 or 5.1 B.t.u. per pound of air. If air alone were considered the value would be 0.24×15 or 3.6 B.t.u. per pound. If the vapor in the air is not considered, the error is about 30 per cent for this assumed condition. For lower temperatures the error would not be so great.



Seals against Fluid Pressure

Part VII Specifications issued by the United States Navy for packings suitable for gaskets, rods, shafts and condenser tubes

PREVIOUS articles in this series on seals have given the essential requirements for materials and construction of packings and gaskets for general use by departments of the United States government. Supplementing these specifications, however, are a number issued by the Navy Department that are more specific in their application and in many cases fit closely the required service in power plants. In the paragraphs which follow, the essential technical features of the Navy Department specifications, which have not previously been presented as Federal specifications, are presented as an aid to engineers faced with the problem of selecting packings for specific purposes.

Oil Resisting Gaskets

Gaskets of the oil resisting type, whether they are of the sheet, strip or molded form, are specified in but one grade. Sheet gaskets must be of uniform thickness, have a smooth surface, and be furnished in rolls 36 to 40 in. wide, a tolerance of plus or minus 1 in. being permitted. Strip gaskets less than 1¼ in. ordered width are cut from sheets of the specified thickness in lengths from 11 to 22 ft. Gaskets are molded or cut from sheet, as required, and of the shape and dimensions and within the tolerances specified.

SPECIFIED TOLERANCES

Thickness (inch)	Tolerance (± inch)	Width (inch)	Tolerance (± inch)
1/16 to ⅛ (incl.)	1/64	¼ to ½ (incl.)	1/32
Over ⅛ to ½ (incl.)	1/32	Over ½ to 1 (incl.)	3/64
Over ½ to 1 (incl.)	3/64	Over 1	1/16
Over 1	1/16		

The compound must have a specific gravity of not more than 1.65 and gaskets are required to meet the following physical requirements: Before aging:
Tensile strength (minimum)...pounds per sq. in. 1200
Ultimate elongation (minimum).....inches 2 to 7½

Hardness:

Thickness, inch	¼	5/16	⅜	7/16	½ or more
Min. indention, mm.	0.76	0.78	0.80	0.82	84

After aging: Tensile strength must not vary more than 20 per cent from the tensile strength of unaged specimens. The compression set, under a specified test at 400 lb. on a sq. in. of material, must not be more than 30 per cent.

After immersion: Gaskets must have a tensile strength not less than 700 lb. per sq. in., and the percentage of swelling shall not be greater than 75 per cent.

In the test for hardness the diameter of the plunger must be 3.2 m.m. Specimens of the material less than ¼ in. thick are superimposed to a thickness of not less than ¼ in. before making the hardness determination.

In the accelerated aging test, the specimen is subjected to dry circulating air in an oven kept at a temperature of 194 deg. F. (90 deg. C.) plus or minus 2 deg. F. for 46 hr. Final determination on aged tension-test specimens is made not less than 20 hr. after removal from the oven. Tension tests of unaged specimens is made immediately prior to, and on the same machine as the tension tests on the aged specimens.

The immersion test for strength is conducted on tension-test specimens by immersing them in a mixture of 85 per cent kerosene and 15 per cent benzol for 46 hr. at 135 to 140 deg. F. temperature. The specimen is then removed and allowed to stand in air at room temperature for 24 hr. before tests are made. The cross-sectional area of the test pieces is determined after removal from the liquid and drying.

To test by immersion for swelling, the weight of water displaced in a Jolly or other suitable balance, by each of three 1 to 2 by 1/16 in. buffet specimens, is determined before and after 46 hr. immersion at room temperature in the kerosene-benzol mixture. After removal, specimens are dipped in alcohol, lightly wiped, and the determination made within 5 min. after removal from the kerosene-benzol mixture. The displacement after immersion, minus the initial displacement, divided by the initial displacement, is considered the percentage increase in volume for each specimen.

Asbestos-Metallic-Cloth Cover, Rubber Core Gaskets

For flame-resistant hinged closures, the Navy Departments specifies gaskets made with asbestos-metallic-

cloth cover with rubber core. The specification covers but one type and grade. The asbestos-metallic-cloth cover conforms to Navy Department Specification 33P2, except that flame-resistant compound is used wherever rubber compound is specified therein. The adhesive used between the cover and the core must be such that it is not possible to strip the asbestos-metallic cloth cleanly from the rubber without the use of solvents.

Gaskets complying with this specification consist of a rubber core, ½ in. square, covered with two plies of 1/16-in. asbestos-metallic cloth, making a gasket ¾ in. square. The finished gasket may have a plus tolerance of 1/16 in., but no minus tolerance.

Flame resistance of the cloth is determined from a specimen of the asbetos-metallic cloth, approximately 3 in. square. When held horizontally in the hottest portion of the flame of an ordinary Bunsen burner for 1½ min., the cloth must not carry flame nor shall the compound have been consumed, when it is removed from the Bunsen flame. To test for heat resistance, a specimen of the gasket is placed with any face across the hottest portion of the flame of an ordinary Bunsen burner for 15 sec. and then cut at the exposed section. There must then be no evidence of melting of the rubber core. These gaskets must not be lubricated with graphite or other material.

Cloth-Insertion Rubber Packing

For cold water or brine up to 250 lb. pressure and for ventilating systems, the Navy Department specifies a cloth-insertion rubber packing in but one grade. This packing consists of alternate layers of rubber and cotton fabric, both faces of the packing being of rubber, or fabric, as specified, and the layers of rubber are of equal and uniform thickness.

It is required that the rubber shall be properly vulcanized and shall contain not less than 70 per cent, by volume, of the best quality new rubber. The acetone extract, corrected for free sulphur, must not exceed 7 per cent, nor the total sulphur, exclusive of that contained in barytes, exceed 8 per cent of the weight of the rubber as compounded. There must be at least one ply of fabric for each 1/16 in. in thickness.

The fabric insertion must have 35 to 50 threads per inch in the warp and filling and must weigh between 4¾ and 5½ oz. per sq. yd. A tolerance in thickness, plus or minus, is permitted as follows: For thickness 3/32 in. or less, 10 per cent; for greater thickness, 5 per cent. The width of this packing, which comes in sheets, is 36 in.

Tensile strength is determined before and after the specimens have been subjected to an accelerated aging test in air at 158 deg. F. plus or minus 2 deg. for 96 hr. The decrease in tensile strength due to aging must not exceed 35 per cent. The physical requirements are as follows:

Tensile strength per square inch, minimum	1700 lb.
Ultimate elongation, minimum	2—11 in.
Set, stretch for 10 min	2—10 in.
Set after 10 min. rest, maximum	25 per cent
Friction between rubber layers and fabric insertions, minimum	9 lb.

Round Cotton Wick Packing

For low-pressure packing of pipe joints, stuffing boxes and similar service the Navy specifies the round cotton candle wick packing in but one grade. This packing is made of the best new cotton, thoroughly carded and wholly free from seeds, lumps or foreign particles of any kind. The wick is made of soft spun cotton, 7 plies to the strand, the separate plies of approximately uniform thickness throughout their entire length. The cotton used must not be bleached or subjected to any chemical process that will change its natural condition and the tension of the spinning must be such as will produce a soft wick that will absorb oil having a viscosity of 200 seconds, Saybolt, mineral at 210 deg. F. (steam cylinder oil). This wick is delivered in balls, averaging 8 lb., containing an average of 26 yd. to the ball.

Unvulcanized Rubber-Graphite Packing

Flanges or turbine casings are packed with unvulcanized rubber-graphite packing which usually has a thickness of 1/32 in. The Navy issues specifications for only one grade of this packing, the compound for which must conform to the following requirements:

Rubber, by volume, minimum	40 per cent
Organic acetone extract, corrected, based on the weight of the rubber as compounded	10 to 20 per cent
Total sulphur, based on weight of rubber as compounded and exclusive of sulphur contained in barytes	10 to 20 per cent
Graphite, by weight	24 to 32 per cent

The remainder of the compound must consist of suitable fillers which may contain barytes, but which must be free from any substance likely to have a deleterious effect on the compound.

No rubber substitute of any kind is permitted to be used, nor rubber which has previously been used, nor any reclaimed rubber. The hardness, measured in depth of indentation produced by a spherical surface ⅛ in. in diameter under a dead-weight pressure of 2.2 lb., applied for 1 min. on a sample at least ⅛ in. thick made up of several layers of the material, must be less than 0.4 mm. The weight of the packing 1/32 in. thick must not be less than 2.60 nor more than 3 lb. per sq. yd., other thicknesses are in proportion. No plus tolerance in thickness is permitted, but a minus tolerance of 10 per cent is allowed.

Graphite determination is made as follows: One-half gram of the sample, cut in cubes, is heated with 25 c.c. of cresol in an Erlenmeyer flask on a hot plate 10 or 12 hr., at approximately 375 deg. F. with frequent shakings. Cool. Add 75 c.c. of benzol. Filter through a weighted alundum crucible and wash thoroughly with benzol. Dry to constant weight. The residue in the alundum crucible consists of graphites and other fillers. A complete chemical analysis shall then be made for all inorganic fillers, such as borium sulphate, zinc sulphide, etc., and their combined weights subtracted from the weight of the residue in the alundum crucible; the difference is taken as the weight of the graphite originally present in the sample.

Carbon Packing

For sealing around steam turbine shafts, carbon packing has been used extensively and specifications have been drawn up for three grades of this kind of packing: Grade I, soft; Grade II, medium, and Grade III, hard. The packing is made of refined coke and/or lubricating graphite, with a suitable binder, and must not contain any abrasive or other material which might affect its serviceability. It must be free from laminations, shrinkage cracks, or other imperfections.

Carbon packing is furnished in plate or ring form to the dimensions specified. The flat sides of each ring are parallel and must have a smooth, even surface. The inside diameter of all rings must be ground true at perfect right angles to the sides of the ring and, unless otherwise specified, must be finished to the nominal shaft diameter with a permissible variation of minus nothing and plus 0.001 in. per inch of nominal shaft diameter. The diameter is measured with segments concentric and all joints butted.

Each ring must be furnished with one coiled garter spring which has such strength that an elongation of not more than 10 per cent is sufficient to hold the segments lightly against the shaft. The specified composition of the spring copper-nickel alloy is as follows:

Copper, minimum	23.0 per cent
Nickel, minimum	60.0 per cent
Iron, maximum	3.5 per cent
Aluminum, maximum	0.5 per cent
Manganese, maximum	3.5 per cent
Carbon, maximum	0.3 per cent
Silicon, maximum	0.5 per cent

The segments of each ring must be marked so that they may be assembled in the same relative position as when manufactured. Composition of the rings of the different grades is as follows:

	Grade I Soft	Grade II Medium	Grade III Hard
Fixed carbon, minim. per cent	96.0	96.0	93.0
Ash, maximum per cent	1.5	1.5	3.
Hardness, scleroscope (Shore)	15-30	30-60	60-90

Shredded Lead Packing

For use on spray valves and fuel-measuring pump plungers of Diesel engines, the Navy uses shredded lead packing which is specified in but one grade. It consists of strands of lead alloy formed in bundles with the strands laid parallel and impregnated with a mixture of flake graphite and oil. Each bundle is 3/8 in. in diameter and 10 in. long and is wrapped separately. The dimensions of the lead strands are 5/64 to 3/32 in. wide and 0.008 to 0.010 in. thick, and the composition of the lead alloy is as follows:

Tin	4.5 — 5.0 per cent
Antimony, maximum	0.25 per cent
Other impurities, maximum	0.25 per cent
Lead	Remainder

The amount of graphite and oil permitted in the finished packing is not more than 5 per cent.

Flexible-Metallic, Condenser-Tube Packing

For the packing of condenser tubes the Navy specifies a flexible-metallic packing in one grade. This packing is composed of a combination of metal rings and fiber rings, the metal rings being built up of a number of layers of babbit foil, and die-formed to the dimensions required by the different tube sizes, the rings being endless.

Each ring must be sufficiently resilient or malleable so that it may be freely caulked into the threads of the tube sheet drilling and hold the pressure, without impeding the free movement of the tube or causing deformation to the surface of the tube. The ring forms a metal contact on both the tubes and the tube sheet In the following table are given the specified metal ring sizes and weights:

Size I.D. Inch	Size O.D. Inch	Size Length Inch	Weight per 1000 rings Minimum Pounds	Weight per 1000 rings Maximum Pounds
5/8	25/32	3/8	20.50	21.00
3/4	29/32	3/8	24.25	24.75
7/8	1 1/32	3/8	27.75	28.25
1	1 5/32	3/8	32.00	32.50

The fiber rings are cut from vulcanized fiber tubing composed of pure cellulose, free from any appreciable amount of chloride of zinc or mineral matter. The tubing must be free from cracks, seams, blisters, and tears and must be thoroughly seasoned and compact and homogeneous so that it can readily be machined without causing component layers to crack or separate. Those rings must be free from burrs and the ends must be finished smooth. Slight chamfering is permitted. They are 3/16 in. long and of the same outside and inside diameter as the metal rings.

Metal and fiber rings must be suitable for a pressure of 50 lb. per sq. in. and a temperature of 200 deg. F., and must not corrode nor otherwise be affected by acids, alkalies, or sewage in the circulating water.

(To be continued.)

For cylinders of gas-engine-driven compressors to handle propane gas at pressures from atmospheric to 130 lb. per sq. in. and temperatures varying over a period of 1 hr. from —40 deg. to 80 deg. F., Clark Bros. of Olean, N. Y., adopted high test nickel iron after extensive tests on wear resistance, and homogeneity of metal structure which gives a smooth, firm bore. The composition of metal used, also used in the engine cylinders to give long life and stability under high temperatures, was: Total carbon, 3.1 per cent; silicon, 1.25 per cent; manganese, 0.8 per cent; nickel, 2.5 per cent; chromium, 0.3 per cent.

Possible tensile strength in iron castings is indicated by the tests of cast cylinders 26 in. diam. by 6½ ft. long for the slide valve controls at Fairmont Reservoir of the Los Angeles water supply system. Specifications called for minimum tensile strength of 50,000 lb. per sq. in. and castings of Ni-Tensyliron made by Madsen Iron Works at Huntington Park, Cal., gave test results of 60,000 to 80,000 lb. per sq. in., transverse strength on 18-in. centers of 3000 to 4500 lb. and deflections of 0.25 to 0.37 in. Hardness was somewhat higher than normal for such cylinders, but they machined readily.

Where Gas Is Cheaper Than Coal

Gas Fired Heating Plant in Portville High School Is Automatic and Economical

BY J. B. NEALEY*

TREND to gas for heating homes and public buildings is gaining headway and "automatic and clean heat" are not the only reasons. In many territories throughout America, gas is almost as cheap as coal on a B.t.u. basis. When coal and ash handling and constant attendance to firing are eliminated, gas is cheaper in many cases. One of these many territories, where gas is the favored fuel, is upper New York State. The coal fired plant at the high school at Portville, N. Y., was converted to gas firing. This was accomplished simply and quickly by putting gas burners in the fireboxes under the boilers.

*American Gas Association.

This school is a modern brick and steel 3-story building with a gymnasium detached and was built for about 400 pupils. The heating plant consists of two steam boilers with a rating of 8000 sq. ft. of steam radiation each. These are of the cast-iron sectional, super smokeless type. Standing radiation throughout the two buildings amounts to 4536 sq. ft. In addition, there is 3888 sq. ft. of radiation for heating the incoming fresh air used for ventilation. The New York State law requires 30 cu. ft. of fresh air per pupil every minute. This is distributed throughout the building by a system of ducts built into the walls. The excess air is removed from the rooms by another system of

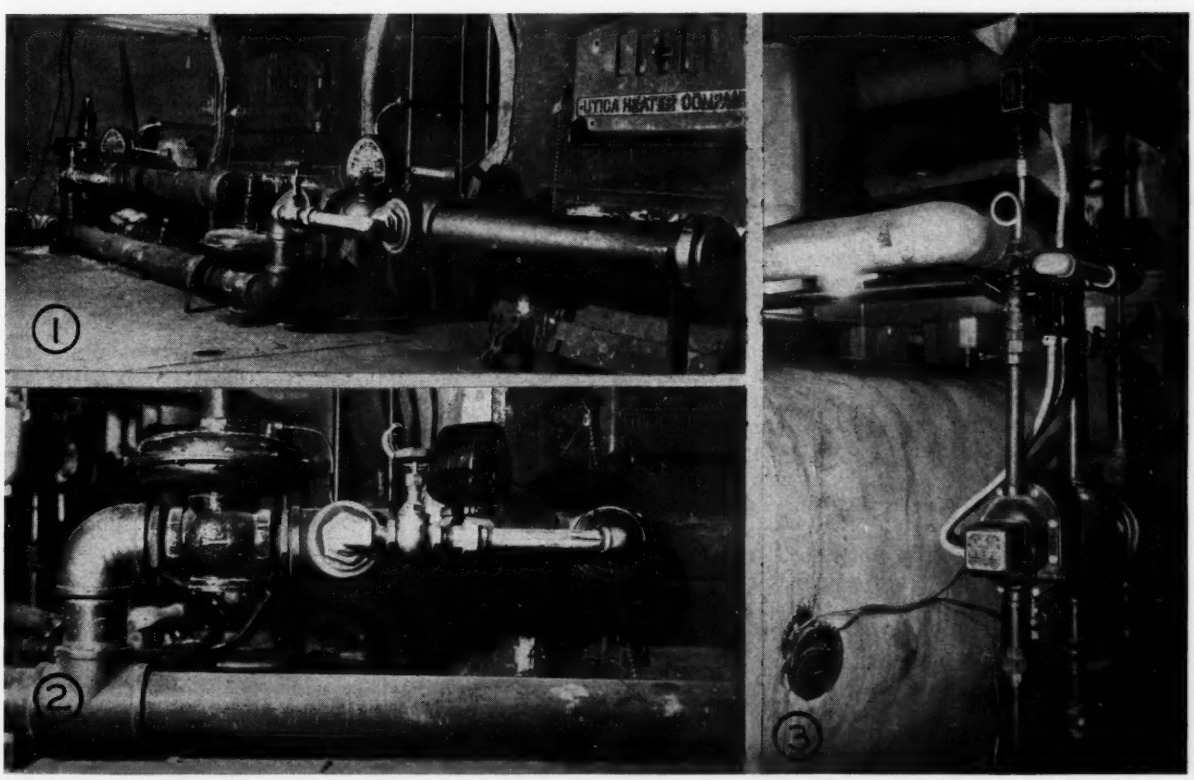


Fig. 1. Manifolds and lead lines to burners. Visible on each boiler are: gas pressure regulator, motor gas valve (controlled by steam pressuretrol) and by-pass piping. Fig. 2. Close up of regulator, gas valve and by-pass. Fig. 3. Gas controls at side of boiler. Pressuretrol on top of pig-tail. Lower center is low water cutoff which closes gas valve in event of low water in boiler.

wall ducts and is exhausted to the atmosphere by means of vents in the roof.

The incoming air is heated to 68 deg. F. by the special radiators or ventos while the rooms are maintained at 70 deg. F. through the standing radiation. These temperatures are controlled automatically and each room has an individual thermostat operating a diaphragm valve on the radiator, by means of air pressure. The control system for the entire building consists of a thermostat and a diaphragm operated steam valve for each radiator and an air compressor, all completely connected by a system of small, concealed compressed air piping. The air pressure is 15 lb. per sq. in. The diaphragm valve is held open by a spring and when the temperature has risen to 70 deg. the thermostat opens the air line, and air pressure, building up against the diaphragm, closes the radiator valve. When the temperature drops below 70 deg. the reverse operations take place. The same system of heat control is used with the special radiators heating the air for ventilation.

Dampers in the exhaust ducts on the roof are kept open during the day but are closed at night, as well as Sundays and holidays. These are operated by pneumatic cylinders attached to the axes of the dampers, and are controlled from the boiler room.

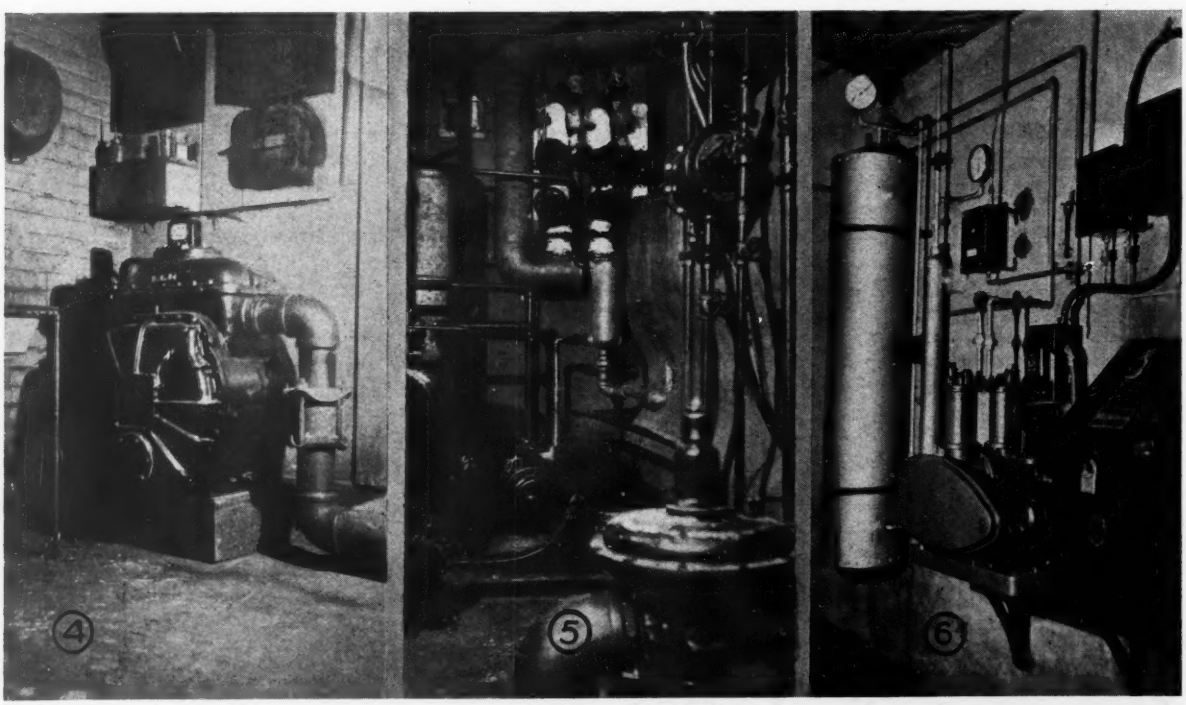


Fig. 4. Gas meter. Fig. 5. Lower front, gas pressure regulator; upper front, low water cutoff and automatic boiler feed; at left, tank and pump that returns condensate to boiler; upper rear, three automatic steam valves on steam lines to the three banks of ventos. Fig. 6. Control room for temperature regulation. The transmitting medium between room thermostats and radiator valves and to operate roof exhaust dampers is compressed air. Here is shown the air tank pump and controls that maintain sufficient air pressure to operate the entire system.

Box Type Gas Burners

Gas burners installed on this job are small cast-iron boxes 2 by 4 by 8 in. high, and they are grouped together so as to make one large bed of flames. Each boiler is provided with 30 of these. Gas and primary air are introduced into the bottom of each and after thorough mixing, burn through slots in the top. A small space (¼ in.) is left between the burners for secondary air which is drawn through an opening in the firebox equipped with a butterfly damper. Each firebox is 40 by 81 in. and, of course, the grates were removed.

Each burner unit consists of two cast-iron boxes, one inside the other, and a venturi mixer. The outer box has a slotted top and closed bottom, and a vertical venturi tube is cast as an integral part of the bottom of this box. The inner cell has an open bottom and closed top, and sits inside the outer box over the venturi tube. This unit rests on a gas supply manifold and rack, with the venturi directly over the gas port. Gas entering the venturi entrains primary air and the mixture rises to the top of the inner box where it is deflected downward to the bottom of the outer box. This, in turn deflects the mixture upward in the space between the inner and outer boxes and it burns from the slots in the top. The result is a thoroughly diffused and expanded mixture of gas and air. The installation is made so that the burner heads are on a level with the former grate line of the boiler.

The 30 units occupy a central position at the front end of the firebox, leaving between them and three of the walls, a 9-in. space, which is closed with refractory slabs. The rear of the ashpit is sealed off vertically with firebrick and cement up to a point within 12-in. of the burners. Gas is supplied by a 4-in. manifold and is served to the burners by 1¼-in. pipes. The gas pressure at the burners is 2½ oz. The steam pressure is regulated by a steam pressure regulator actuating a

motor gas valve in the gas header. This control opens the gas valve at 1 lb. steam pressure and closes at 3 lb.

Preheat Ventilating Air

There are three banks of ventos or radiators for preheating the incoming ventilating air before distribution to the classrooms. Also, there are three automatically controlled steam valves in the steam lines to the ventos. The valve on the first bank is operated by inlet air temperature, and when this is above 40 deg. F. the valve is closed but the valve opens again if there is a drop below this temperature. This is a precaution taken to prevent freezing of the coils and acts independent of the duct temperature.

Valves on the second and third banks of ventos are actuated by duct temperature at the outlet side of the circulating fan. When the duct temperature falls below 70 deg. F. one valve opens and if it falls below 68 deg. F. the other opens. Both close at one degree higher than the temperatures at which they are set. The idea back of this arrangement is to furnish the ventilating air to the classrooms at 68 deg. F. slightly under the 70 deg. F. required. This throws the maintenance of the room temperatures onto the standing steam radiation therein, which, in each room, is regulated by thermostat and radiator steam valve as described. If the temperature rises above 70 deg., the 68 deg. air helps cool it. This helps to eliminate cost and over jumping of the room temperatures.

Safety Controls

Uniform firebox draft is maintained by an adjustable self-balancing check damper installed in the breeching to the stack. The butterfly damper in the secondary air intake is direct connected to an arm on the shaft of the gas valve motor and closes and opens with the corresponding movements of the gas valve. There are two safety devices, the first of which is a low water cutoff cut into the valve motor circuit so as to close the gas valve in case the low water level is reached. The other is a small pilot flame playing on a bimetallic strip which also acts to close the gas valve through the motor, in case of flame failure.

These boilers are in use from September until June and the consumption of gas (1060 B.t.u.) in this period averages 2,300,000 cu. ft. At an average of 35c per M.C.F., this amounts to $805. Coal consumption, previous to the conversion, averaged 156 t. per season; at $6.00 per ton, this amounted to $936. The old coal storage space was converted into a lunchroom for out-of-town students. Additional saving was effected through the elimination of coal and ash handling.

Bearing Renewal Pitfalls

Adjustment for Wear Presents Perplexing Alinement Problem

BY ELTON STERRETT

COMPLETE interchangeability of parts, practicable on new machinery, sometimes fails to work out as satisfactorily when one new part is introduced into an assembly the other components of which have seen much service and are therefore worn appreciably from their former dimensions.

An instance in which this fact was brought to light, after causing much worry to the operating personnel, occurred on a battery of herringbone gears serving as speed reduction drives on six duplex 4½ by 24 in. plunger pumps, discharging crude oil under an initial or station pressure of 900 lb. per sq. in., after some 20,000 hr. of trouble-free service in 4 yr. of running.

Chafing of the main and pinion shafts against the oil retaining rings outside the bearings gave warning of wear limits in the lower halves of the babbit-lined bearings and required an adjustment or resetting to bring the herringbone reduction gears again into proper mesh.

As opportunity allowed, each of the six units was stripped of gear cover, the lower bearing—B of Fig. 1—examined carefully, and then sufficient shim stock inserted between bearing B and the pump bed casting C to bring the main and pinion shafts again on the level at which they had been installed originally. Where inspection showed the quarter-box F also worn, but still serviceable, "Dutchmen" or shim steel liners were attached to the flat face bearing against the side of the bed casting, and the original distance between pinion and main gear shafts thus again obtained.

Five of the six pumps responded to this drive overhauling and realinement program without subsequent trouble, but Unit 3 of the battery developed a queer and for some time inexplicable trait which showed up each time the unit was put on the line.

Always, when tied in to the pressure manifold, this unit ran as smoothly as did the others at the outset, but one side would heat up after some 30 min. at full load, and it would be necessary to back off on the adjusting screws, D-D, behind shoe A to prevent scoring. Check of the oiling failed to uncover any fault or failure there and always, after backing off to give additional slack,

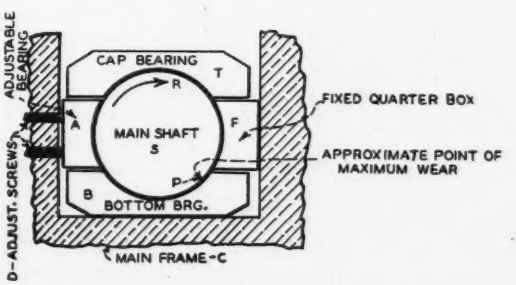


Fig. 1. Diagrammatic sketch of bearing set-up on reduction unit causing unusual trouble

the unit would run without heating, on the former lubricator adjustment, though at times a pronounced thump would accompany and herald each reversal of stress as the rod passed forward or rear dead center.

Careful check of the bearing failed to bring any abnormality to light, and the adjustment was again made here as on all other pump drives—by setting up the adjusting screws, D-D, tightly and then backing off one-eighth turn.

When operated on the bypass, and therefore without load, the unit operated smoothly and noiselessly; but when again set to bucking the 900-lb. line pressure, the trouble promptly returned, and again it was necessary to slack off on shoe A to prevent scoring.

On this pump unit, and this one alone, the bottom bearing B had been found badly checked and cracked, and, after the usual scrapping to fit, a new shoe had been installed at this point. But, since a recheck with Prussian blue showed ample bearing contact, it was felt that the shoe could not be to blame, and the gears were checked for alinement. As expected, they showed the desired rectangular band of contact, roughly bisected through its length by the pitch line of the gear. With the gears again clear of suspicion, the new bearing was, must be, the cause of the trouble.

When a sketch of the bearing, similar to Fig. 1, was made and a rough graphic determination of forces and stresses therein made, the underlying cause was located. As shown by the arrow at P in Fig. 1, the maximum pressure when operating, being the sum of the components derived from rotatory force, gravity or gear weight, reaction between gear teeth and plunger resistance, acts in some direction and at or near the spot indicated by P. This concentration then causes the greatest bearing wear to come, not directly under the center of the shaft S, but at some point in this case about 35 deg. counterclockwise to the projected shaft center—rotation being as indicated by the arrow at R, in a clockwise direction—from which it becomes apparent that the lower or trailing edge of the nonadjustable side bearing F sustained the greatest part of the wear occurring in this section of the unit.

Since the bearing wore gradually to accommodate itself to this concentration of forces, it follows that the arcs of contact between shaft and shoe F remain practically constant, but instead of the chord of this arc remaining perpendicular to and being bisected by the center line of the bearing, it gradually moves below and at a slight angle to it.

Shimming the other lower bearings and adding "Dutchmen" to other shoes at F as the unit overhauls were made in no way shifted the relation of worn sections B and F, and in consequent operation no trouble was experienced. But, installing the new bottom shoe on this particular unit, the shaft was raised relative to the line where shoe F rested on bearing B, and the bearing F had to rise or float upward to bring its arc of contact into conformity with the curve of the shaft.

Under the force of the adjusting screws at D, this shoe would rise appreciably—once this trait was suspected and watched for—indicating that it failed to rest on or be supported by the lower bearing. Without rotatory force to urge the side bearing toward contact with its normal support, the peculiarity of overheating failed to show up during adjustment or operation under no load. But, once rotation under working loads was begun, the drag of the shaft against the bearing tended to force it downward toward its former seating on B, with a consequent wedging action along the upper edge of F, acting to scrape off the lubricant and thus quickly cause overheating.

Once suspected, the blame attaching to this condition was made certain by shimming the gap between B and F until there was no motion possible under rotating load.

In the course of the routine overhaul, spots on the interacting gear faces were thoroughly cleaned of lubricating compound and then rotated through a normal cycle of contact. In each instance the test, with the cleaned spots touched up with Prussian blue, showed that the section of wear had moved outwardly along the teeth from the proper position across the pitch circles of both gear and pinion so that—illustrating but one side of the herringbone gear for simplicity

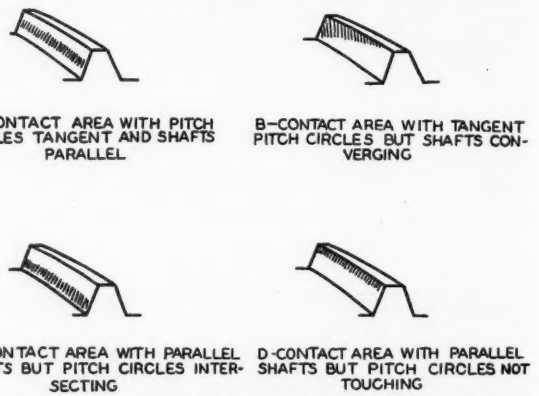

A- CONTACT AREA WITH PITCH CIRCLES TANGENT AND SHAFTS PARALLEL
B-CONTACT AREA WITH TANGENT PITCH CIRCLES BUT SHAFTS CONVERGING
C- CONTACT AREA WITH PARALLEL SHAFTS BUT PITCH CIRCLES INTERSECTING
D-CONTACT AREA WITH PARALLEL SHAFTS BUT PITCH CIRCLES NOT TOUCHING

Fig. 2. Types of tooth contact in herringbone reduction units under varied pitch circle adjustments

of determination of contact sectors—the wear may be said to occupy some area as at D in Fig. 2. Had the readjustment of shafts brought the gears close enough so that their pitch circles intersected, the area of contact would be as at C in Fig. 2.

Assuming erroneously that no-load and full-load bearing conditions would be similar was responsible for much of the time frittered away attempting to pin down the elusive cause of the overheating on Unit 3. A test under loaded conditions with the bypass closed and men enough massed on the engine jack-bar to build up working pressures—carried out before the shims were put between B and F as outlined above—showed a shift in pressure areas on gear teeth similar to, but not as pronounced as that shown at B in Fig 2. As the shading indicates, the load is concentrated on the outer corner of one side of the tooth, without the remainder of the normally contacting surfaces meeting with pressure enough to affect the Prussian blue.

Comparison of this shift in pressure area between pinion and gear tooth as found under pressure and with no load would have immediately indicated the presence of angularity between the two shafts when a load was imposed. This shift under working conditions could have occurred only through some alteration in the relative positions of the restraining sections of the bearings—Section F of Fig. 1—as only through some such movement could previously accurately alined shafts show misalinement.

Efficient FLY-ASH Collection

By Stanley Brown*

SOME engineers think that the value of the eliminator rises directly with the total collection efficiency which it exhibits. According, however, to a reasonable sizing acceptance as defining the lower end of the nuisance range, the following thought is of interest.

An overall collection efficiency of 90 per cent might be had according to the catching of an exact 90 per cent of all of the various particle sizes, while a device providing an overall efficiency of 80 per cent might actually accomplish an average efficiency of 95 per cent collection throughout the nuisance range, and if so, this would be the preferable offering.

What is required? If we consult our brothers on the Continent, where there are many times the number of fly-ash eliminators that have been installed in the United States, we find the following reply:

"In about May of this year, the imposed requirement for avoiding fly-ash nuisance was carefully refined to the specification that the collector must catch 90 per cent of all particles of 30-micron size (sub-mesh 500) and larger."

In this regard, Dr. Otto Schoene, Engineer Professor of Charlottenburg University, who has had extremely broad experience in fly-ash study, advises that if a fly-ash eliminator could accomplish 90 per cent collection efficiency of all particles of 20-micron size and above, the result would be beyond criticism.

Are we sufficiently "size conscious"? It may be stated that the smallest size of particle which is usually observable by unaided eyesight, with 12 foot-candles of illumination, is approximately 35 microns (sub-mesh 450).

Of further interest, the finely ground cosmetic powders of the "air-spun" variety (prepared in special micronizers), comprise particle size of about 27 microns (sub-mesh 530).

Let us now give a moment to the consideration of falling time as related to particle size, and assume the moderate stack height of 130 ft. with the discharge velocity from the stack sufficient to carry the particles another 50 ft.

The following table gives the expression of authorities as to falling time in still air for the height of 200 ft.; and by a separate column there is indicated the distance that the particles of various size would travel before traversing the vertical distance of 200 ft. when subject to a breeze of 5 mi. per hr. In this regard we have weather statistics which give the report that it is extremely rare that at a height of 200 ft. above ground the air motion is less than at the rate of 5 mi. per hr.

Sizing of Fly-Ash Particles		Time to to Fall 200 ft. in Still Air	Miles of Travel (in 5-mi. breeze) while falling 200 ft.
Microns	Sub-Mesh		
20	625	0.715 hours	3.58 miles
10	1250	2.40 hours	12.00 miles
5	2500	9.20 hours	46.00 miles
2	6250	85.60 hours	428.00 miles

It is also of interest to note that a significant element within the term "nuisance" is the per cent of combustible resident in the fly-ash particles. Since this content greatly increases with the increase of particle size, we further see the wisdom of attacking the "offenders" which are the most objectionable.

With the above thoughts before us, may we not conclude that if the dust has a value, it is of interest to consider its catching in terms of total collection efficiency? Whereas if the dust is merely annoyance, let us deal directly with the nuisance range.

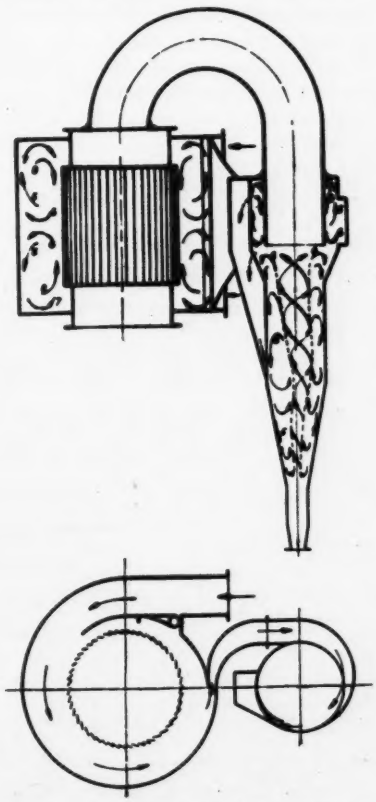


Fig. 1. Compound type dust eliminator

*Engineer, Buell Engineering Co., from a discussion before the A.S.M.E.

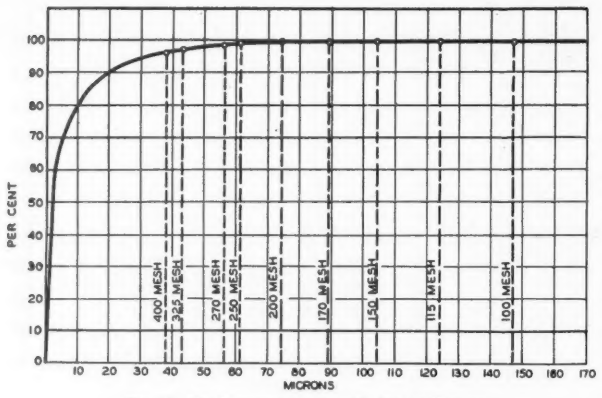


Fig. 2. Performance curve of dust collector

Highly efficient equipment for this service is represented by the Buell compound type of dust eliminator, comprising primary and secondary; or, differently speaking, a concentrating chamber and a highly educated cyclone. The total gas to be cleaned enters the primary, the dust seeks a position adjacent to the volute casing, and is shaved off with 10 per cent to 15 per cent of the total gas for actual collection in the secondary. Figure 1 indicates the double-eddy current flow establishment in the primary and in the secondary. It will be noted in both instances that the influence is outward at the meeting of the eddy-currents, and it is at this zone that the cleansed gas is discharged.

The cyclone is seen to be quite different from the earlier art in the features of:

Low position of gas inlet to the top cylinder; low position of the mouth of the outlet pipe, by-pass dust channel, increased ratio of overall height to a diameter of top cylinder.

The provision of the above design items gives a dust concentration space above the gas inlet and permits from this zone a steady shave-off of the dust for by-pass through the outside dust channel (away from the mouth of the outlet pipe) for re-entry at the mid-cylinder in such fashion that the downward flow of the lower half of the double-eddy current promotes the travel of this dust to the bottom dust outlet.

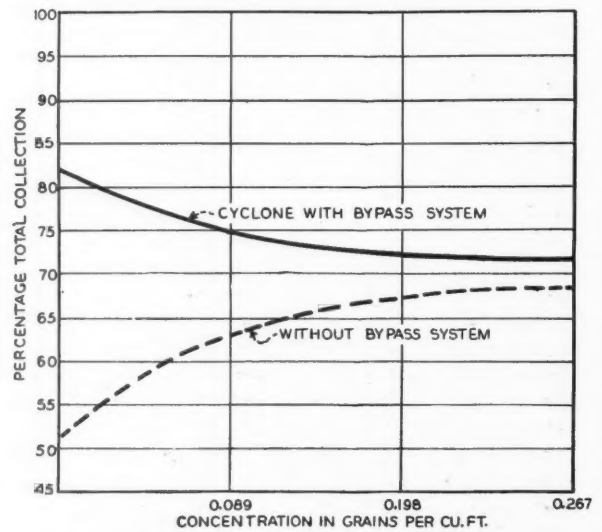


Fig. 3. Performance of cyclone with and without by-pass

Figure 2 shows performance curve in the expression of relation between particle size of fly-ash and collection efficiency.

It is of incidental interest to note that the many tests showed average collection efficiency variations of less than 0.4 per cent difference for the various particle sizes according to the character of combustion origin, such as whether the firing was by pulverized coal, stoker-fired coal, or stoker-fired lignite.

Figure 3 gives additional data of interest related to this cyclone collector. These two curves show cyclones of similar design, with the exception that the cyclone represented by the lower curve has no dust by-pass system, whereas the cyclone corresponding with the upper curve is equipped with the low gas inlet, the dust concentration zone above it, and the outside by-pass channel.

It will be noted that at all points the cyclone equipped with the by-pass system is above its companion, and that at the extreme light loadings the efficiency characteristic is distinctly upward.

In the matter of selective elimination, it may be mentioned that if we unnecessarily collect the extreme fines, it will but magnify the expression, "What are we going to do with it after we catch it."

It is recommended that the value of an eliminator be rated directly in terms of its ability to collect the ash within the nuisance range.

Scale, Oil and Leaks

By D. C. Baker

TO MAKE a collar and necktie job out of a very dirty one, try overhauling the stoker this way: First, take an air hose and clean around the parts. Blow from all directions. The extra minutes spent will repay you. A couple of old bags laid down at the beginning also saves much time and assures cleanliness. Have an old oil drum cut in half. Fill one-half with about 5 gal. of coal oil, in the other half build a rack from a couple of 2 by 4's laid across the bottom and then as cross pieces so that parts will drain. No washing is necessary. Dunk them in coal oil and let drain. Keep tubs close together. This permits you to work on job and yet be presentable for other duties.

I find a good way to remove scale from an H.r.t. boiler bottom is to allow water to all drain out. If in a hurry to get back drag a dry bag back and forth with a small rope to remove all water by soaking it up. It is impossible to remove scale with scraper as there is no way to get in except through the hand holes at the bottom. Take a large sledge hammer and strike plates at bottom (not too hard or near rivets) but just enough to loosen scale which can be easily removed. This will remove scale from the tubes as well.

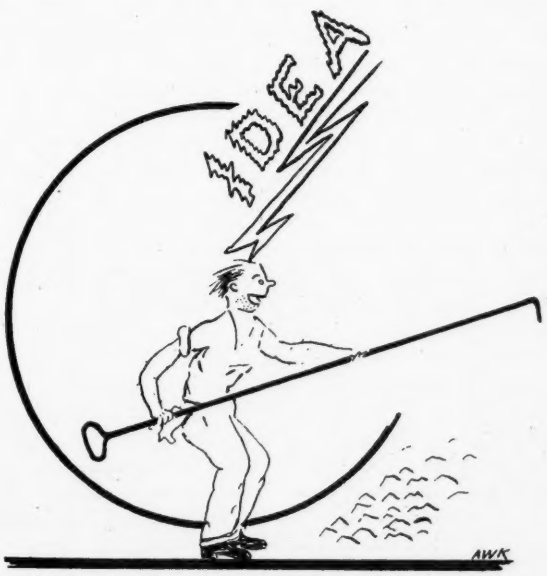
In cleaning an open feedwater heater we had to get it back in a hurry. After filling with water and getting it in service it developed a bad leak. We made a temporary repair. One of the lower doors leaked badly. It was a case of shut it down or fix it. A piece of white pine wood was shaved down thin, wedge shape. We drove it in very quickly as the wood swells as soon as the water hits it. This has lasted 6 mo. It also works on bad steam leaks. Drive it in fast is the secret.

Here is an article for those who, in their odd moments, have toyed with the idea of writing something for one of the technical magazines but who have hesitated to give expression to their thoughts because of lack of writing experience.

How to Write an Article for Power Plant Engineering

AT LEAST ONCE in the life of every disciple of James Watt comes the urge to write something which he knows should appear in print. Whether it be your fate to twirl a scoop in the boiler room or to solve the mysteries of the third harmonic by tensor calculus in the front office, this urge is the same—you are struck with an idea—an idea which you are positive has never been expounded before. So you resolve to immortalize your name in undying print; you plan tonight to write an article for Power Plant Engineering.

But alas, and perhaps hooray, most of these literary aspirations never materialize. Their mortality rate is enormous; most of them never even reach the embryo stage. Usually, about 4 o'clock in the afternoon friend wife calls up and announces that the Jones', or the Dooleys' or the Van Swiggins' are coming over for dinner, and, "on your way home, will you please stop at the A & P for a pound of butter?" So your literary plans for the evening are shattered and their substance dissolved into the nothingness from whence they came. The next morning you come to the plant with nothing but a dark brown taste and a grudge against the democrats—or the republicans. If you *do* give the matter another thought, you decide the idea "wasn't so hot" after all and you proceed to forget it, usually to find it in some magazine some time later fully elaborated and with some other fellow's name signed to it.

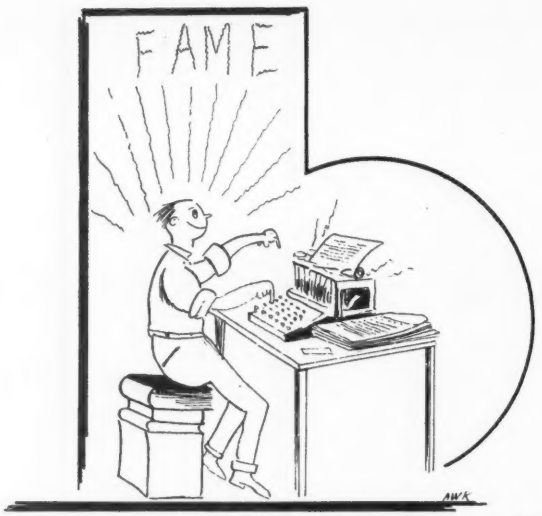


You are struck with an idea

Now, there is only one excuse for this and that is laziness—plain, downright laziness. If you think you have an idea, something that may interest others, sit down and write about it; it is not so difficult, nor is it so easy. Writing, that is technical wrting, is largely a matter of application. Some people think that writing, all writing, is a God-given gift and that those who indulge in it don't have to think, that their words and sentences just flow from the point of their pens like so much ink. This is just so much baloney. True, writing—real literary writing—is an art and some write more easily than others, but some of the finest writing in the world has been the most difficult. The only reason your idea was not presented in print was because of mental inertia—plain laziness.

Realizing that "writing" is rather a formidable undertaking for many people, it is our purpose here to show how to go about putting an idea into words so that others may read. Not that we have hopes of teaching anybody how to write, far from it, but by means of a few suggestions we may be able to make this whole business of writing less mysterious and less terrifying and in the end perhaps contribute something to the betterment of technical literature.

The first thing of course is to have something to write about. This may come from any of a number of different sources—from something you have done, from an accidental happening, from a conversation, from reading an article or, in rare instances, from divine inspiration. Whatever the source, or whatever the idea, the important thing is to have clearly in mind what you want to write about. To start off in a "half baked" manner without clearly knowing what your argument will lead to, leads only to confusion. Unless you thoroughly understand a thing yourself you can never hope to tell anybody else about it. So before you start, clear up all hazy matters in your mind. Be sure you understand the fundamental principles of the ideas involved. If, for example, you are discussing the action of a stoker, be sure you understand the fundamentals of combustion. This does not



You resolve to immortalize your name in undying print

mean that you must be a combustion engineer, but you should know enough about the principles of combustion so that you will not make false assumptions. If it is the operation of station auxiliaries you have in mind, you should know something about the principles of heat balance. So before you begin, refresh your memory by referring to accepted sources of information. Find out what has already been published on the subject.

If you do this you will not only conserve your own time and effort but you will greatly reduce the suicide rate among editors. Many a perfectly good technical editor has lost his reason trying to find his way through the amazing and bewildering array of half-baked mental aberrations which fill so many manuscripts. True, editors do not deserve any consideration but since they have the power to accept or reject your manuscript, it is well to humor them and to keep them happy.

The editor, after all, is not as formidable a person as his title indicates. If at times he is irascible and fractious, remember he is not entirely to blame; remember that he is the constant victim of hordes of space writers, who make his life miserable with reams of vacuous tripe. But if you have an idea, something which you believe has some degree of merit, you will find the editor a reasonable human being only too glad to cooperate with you.

Now for the article. Assume that you have a certain amount of facts on which to base your discussion. Begin by picking out those facts which you believe will bear out your ideas and which will interest your readers. Here is where you can display admirable discretion. Don't try to cover the entire field of human knowledge; that has been done quite effectively by the Encyclopedia Britannica. An artist creates an attractive picture or pattern by concentrating upon a limited number of salient features of his subject to the exclusion of everything else, and the literary artist should follow the same procedure. The average person, usually, can assimilate four or five new ideas at one time but more than that will weary him; a smaller number is better. Remember, you are trying to put an idea across, you are not writing for your health—not usually.

In deciding upon the essential facts, it is well always to put yourself in the reader's place; look at the subject you have in mind through his eyes. Think of what you would like in an article of this kind; review your material from this point of view. Think of the many articles you have read, through which in a frenzy of despair you struggled over page after page only to find at the end that the nit-wit that wrote it did not know himself what he was trying to convey. Forget the history of civilization and the amoeba—everybody knows about these things and nobody cares; furthermore, there is an abundance of handbooks and encyclopedias in the world.

Once you have a clear mental picture of the subject in mind, crystalize it by putting it down on paper in the form of a rough outline. This may just be a list of the points you wish to cover and in the order in which you intend to cover them. Whether you find it convenient to actually use such an outline in your writing or not is a matter of opinion; some say they are unnecessary, others swear by them. But whether you actually use it or not, putting the facts down in logical sequence will serve to show you whether your thoughts are clear and whether you have the essential facts.

While no hard and fast rules should be made regarding this subject, usually it is simpler to present the facts in logical sequence. In describing a steam power plant the general features may be presented in a short introduction.

The question of starting an article is one that admits of certain differences of opinion, but for certain types of articles, certain procedures have been found to work out. Dr. William Easton of the Westinghouse Electric & Mfg. Co., discussing this question in the Electric Journal some years ago, indicated the structure of various types of articles by the series of curves on the next page. Curve A represents the interest structure of a collection of facts of equal weight, such as a description in a catalog, a list of parts, or a chronological table. Such a structure, as Dr. Easton points out, is ideal for reference purposes but being utterly monotonous has no application in an engineering article. Curve B is the structure of a business magazine article as written by an inexperienced writer. Its faults are: a tedious introduction, the use of a large amount of hackneyed matter, a complete break in the flow of thought, a premature climax, and a long anti-climax. If the intrepid reader resolutely forces himself past the introduction, he finds numerous places where he is invited to stop and do something more attractive, for instance reading "Ballyhoo" or "True Confessions" or playing backgammon.

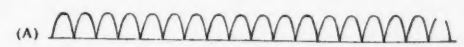
Curve C illustrates the structure that the experience of thousands of years has shown to be unsurpassed for sustaining interest. It starts in an interesting way and then gradually and without interruption builds up with incident or data of ever increasing interest until the climax is reached, after which there is a rapid close. This is the structure of the successful drama or the story which you cannot put aside until

you have finished. It is also the best possible structure for a technical article.

In curve D we have an entirely different structure, the news story type used by the newspapers. The chief points of interest are all placed in the first paragraph and after that there is a regular diminuendo of interest. It has two advantages for newspaper work, first, the main features of the story are placed where they are read by a hasty glance, and second, it permits the editor to fit it into smaller space by merely lopping off final paragraphs. This, of course, cannot by done with an article of the form C. The D type structure is also the useful one for advertisements and for purely descriptive articles.

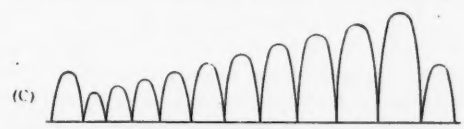
So much for structure. With the facts in mind and a general knowledge of the form in which you want to present them, the expansion of the outline into an article is comparatively easy. Contrary to popular opinion, the writing of a technical or engineering article does not require any particularly literary ability. A knowledge of grammar is useful but not essential. Express yourself directly in simple language. Use short, concise sentences and don't use words you don't know the meaning of yourself. If an article needs polishing up, leave that for the editors—they have nothing else to do and it fills them with a sense of importance. And finally, keep your article short. Space, in technical magazines, is valuable and editors are much more likely to consider an article that will go into one or two pages than one which takes up from 3 to 4 pages. The chances are, if you don't do this, the editors (a ruthless tribe) will cut it to that space anyway, to the dissatisfaction of everybody concerned.

Having written the article, perhaps you think all you have to do is mail it. You are mistaken—there

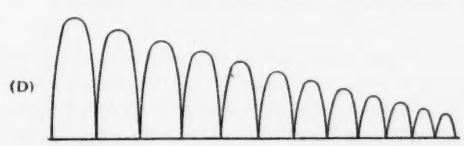


The catalog type of description consists of a succession of facts of about equal interest—making very monotonous reading

A poorly-written technical paper has scattered peaks of interest, and one or more complete breaks in continuity of thought

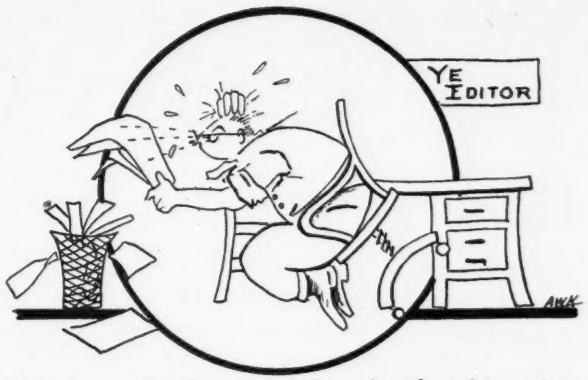


A well-designed technical paper starts in an interesting way, builds up without interruption to the climax and closes quickly



The newspaper story gives the outstanding facts first so that the reader can stop at any point and not miss the essentials

You select an appropriate type of article, avoiding B, over which generations have puzzled and—



Many a perfectly good editor has lost his reason

are several important things that remain to be done, one of which concerns illustrations. It is seldom that the value of an engineering article cannot be greatly enhanced by a few photographs or drawings; indeed, many descriptive articles are absolutely useless without them. As a matter of fact, it is advisable to have the illustrations even before you begin to write the article.

"Illustrations!" you expostulate, "suppose I haven't any?" Well, what about it, can't you make some? Are you just plain dumb?

Perhaps you cannot furnish drawings or blue prints but you can always make a rough sketch or two which even an editor might understand. That is all he requires, for usually he (ye editor) has a draftsman or artist at his elbow to convert anything from an Egyptian hieroglyphic to an entropy diagram into something the reader can understand. Often charts from recording instruments make illustrations depending of course upon the nature of the article. Photographs are always desirable and an effort should be made to supply them. Nothing sells an article to both the editor and the reader as do good photographs. These need not be 8 by 10 professional affairs; often small views taken with Kodaks will serve nicely. If they are clear they can be enlarged and the editor will take care of that. But if you can furnish nothing else, at least send a few sketches.

Now all this sounds complicated and to some extent formidable, but really it is not. Work? Yes, of course, it is work but real accomplishment always involves work. If you try to interest other people without work you probably will end up by boring them. Perhaps your first effort will not be satisfactory, but don't let that discourage you. Lay it aside for a few days and then pick it up and read it over again.

Perhaps this will discourage you more and you will grow tried of the whole idea and you conclude that as a writer you are a dud and your inclination is to scrap the whole sorry mess and go out and get drunk.

But, as Dr. Easton says, the experienced writer knows that this state of mind is "the darkness before dawn." Suddenly you will find that the subject with which you have been dealing dominates your thinking consciously and subsconciously and gradually the ideas begin to take on a new semblance of order in your mind. Soon you tackle the job again and you do it with ease. You have become a creative being.

Readers' Conference

Ingenuity in the Plant

PLANT ENGINEERS must exercise considerable initiative if they are to meet and successfully cope with small problems which arise from day to day. The two accompanying photographs, taken in the plant of the Michigan Carton Co., Battle Creek, Mich., shortly after the new boiler plant was completed, both show considerable ingenuity which should be of interest to other plants. A description of the new high pressure boiler appeared on page 641 of the November 1936 issue.

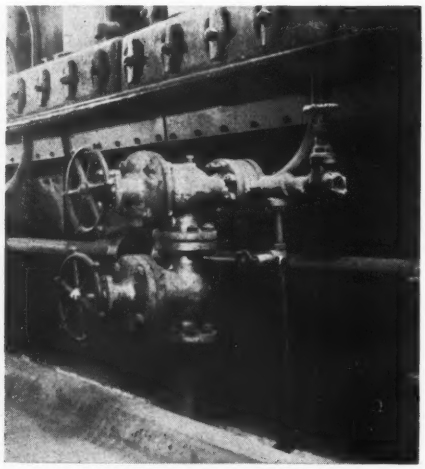


Fig. 1. Continuous blow-down connection on high pressure boiler

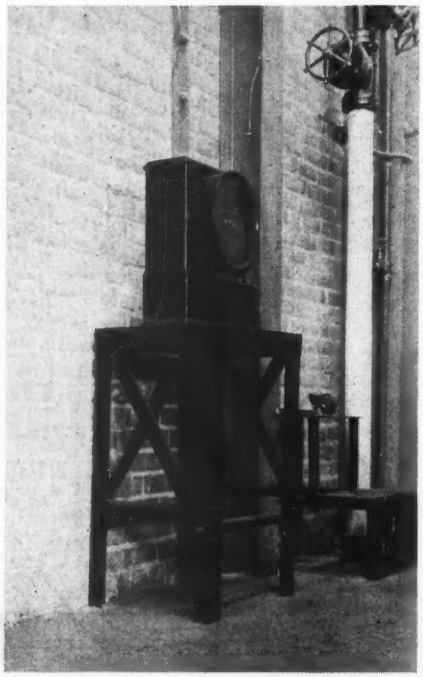


Fig. 2. Welding can be used to advantage for odd jobs around the plant

Figure 1 shows the method of making the bleed connection from the blowoff line for the continuous blow-off system. This bleed connection is welded to a block of forged steel, machined and drilled so that it fits between the flanges adjacent to the first blow-off valve.

Figure 2 demonstrates uses for welding and scrap material around the plant. The stand upon which the CO_2 meter rests is of simple construction, easily made and raises the CO_2 meter to a convenient height for reading, changing charts and repair. When the photograph was taken the meter had not been put into service. Behind this stand are two steps made from old pipe and steel flooring. Steps are used to reach the blowoff valves which in this particular case were placed high to avoid extra connections subjected to full boiler pressure.

Remodeling which is always going on around an industrial plant always produces a great deal of scrap material which, with a little thought, may be converted into useful appliances for the plant.

Reduction of Belt Slippage

THOSE WHO think of belt slippage in an abstract manner make a great mistake, for it is an actuality, and there are a great many places where it is costing much money. Belt slippage not only causes a loss in terms of power, but is also a factor in shortening the life of a belt, especially where conditions are in the least abrasive. In many places, four years or less is all that can be realized in belt life, largely due to slippage of the belt on the pulleys.

There are different ways in which slippage may be cut down or eliminated, but in practically every case the thing is based on getting a greater area of actual belt and pulley contact. Greater area of contact may be obtained by going after greater arc of contact, and in order to do this, many firms have installed wrapper pulley drives, in which a third pulley is used to wrap the belt, left slack for this purpose, around the driving and driven pulleys a little more.

Somewhat the same thing can be realized on many drives by running the belt more slack and keeping it soft, pliable and adaptable for gripping the surface of the pulleys by the use of a suitable dressing. In any event, stretching a belt like a fiddle string defeats the object of obtaining greater efficiency. It robs the belt of its life and resiliency, as well. Let it always be remembered that when a belt is harsh, dry or lifeless, it cannot make uniform contact with the pulley faces, and if it does not contact efficiently, it certainly cannot pull efficiently.

Another means of obtaining greater area of belt and pulley contact on a given drive is to increase the length of the belt and the diameter of the pulleys. The same delivered speed can be maintained by increas-

ing the sizes of both pulleys, yet there will be far more contact areas. Yet again, the width of the belt and its pulleys, may be increased for the same purpose. It will be seen, therefore, that the owner of a slipping belt drive has many choices as to the means he will use to overcome it. It simply is a matter of making a study of the individual case, and selecting that method which seems to be the best adapted.

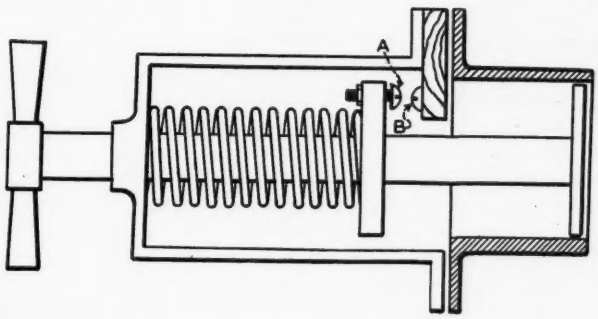
Peoria, Ill. JOHN E. HYLER.

A Simply Installed, Reliable, Easily Tested Low Coal Alarm

COAL used in pulverized fuel systems often hangs up in the spouts leading to the mills. This occurs when it has been some time on the pile or when it is rather finer than usual and has become very wet.

Although, in theory, boiler operators must be constantly on the alert for this condition, actually, they may very easily be caught unaware and the accompanying sketch shows a simply made alarm which will warn him of this condition in time to prevent possible loss of fire.

The device can be fitted at any convenient height up the spout between bunker and feeder, obviously the higher up it is fitted the more time there will be to remedy the condition before the fire is lost. Yet, it should not be too high to be easily reached, as frequent testing (once a day) is desirable.



Briefly, the device consists of a bracket of 1½ by ⅜ in. flat stock bent to form a saddle. An ordinary piece of ¾ in. round stock has a handle at one end and two collars pinned, threaded or spot welded as shown. The feet of the saddle bracket are not in line as, under one foot is a piece of hard wood or fiber to insulate one contact which consists of an ordinary round headed screw. The shaded portion shows a half section of a piece of ordinary pipe in which the end collar moves freely and to which two lugs are spot welded, one at each side. The space marked is filled with a fairly light coil spring. A small screw and nut, threaded through the second collar, contacts the other screw when the rod is at the end of its travel.

It is desirable to key the rod against turning or else widen the head of one contact so that, at the end of travel, they will engage and make sure contact. At the desired place on the coal spout cut out a circular piece of a diameter equal to the inside diameter of the piece of pipe. Drill two holes in the spout and bolt the pipe inside the spout and the bracket outside with the piece of fiber or hardwood under one foot, as shown. Now the rod will move freely in and out when pulled, the spring keeping it in the right hand position when the hand is taken from the handle. Adjust the screw and nut so that good contact is made. When the spout is filled the pressure of the coal acting on the end collar will break the contact between the screws. When the coal goes below the collar the spring will force the plunger in and contact will be made again. Now, all that is needed is a dry cell, an electric bell and some wire. Connect screw A to battery, battery to bell, bell to screw B. The object of the large center hole is so that no coal can collect behind the end plunger and impede free action.

Passaic, N. J. MARK BELL.

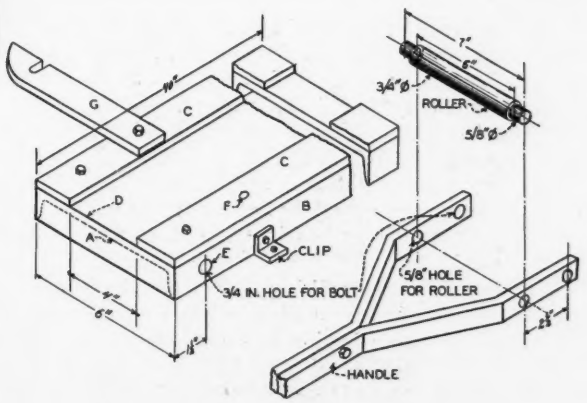
An Easily Made Bus-Bar Bender

THE BUS-BAR bender shown in the sketch has proved highly satisfactory for bending ¼ by 4 in. copper bus-bar, is easily constructed at small expense and will prove a useful tool giving many years of hard service at no cost for maintenance.

The bed of the bender (B) is made from a piece of 6 in. channel with re-inforcement at A which is a small piece of steel welded in place to strengthen the channel where most of the pressure is exerted. Two pieces of ¼ by 1 in. flat iron (C) are bolted to the flat side of the channel, between which the copper bar is placed when a bend is to be made.

The edge (D) over which the bend is made, is rounded off slightly so the copper is not damaged. The lock-bar (G) is used to hold the copper bar in place, being fastened by a bolt through hole F.

Two or three clips as shown, are placed on each side of the bender to bolt it in place to a column or



other support when bus-bar is to be shaped. The handle is made from two pieces of ½ by 1¼ in. flat iron, the entire handle being 40 in. long. Ninety degree bends are readily and rapidly made with this bender.

In assembling the parts shown, the fork of the handle is placed over the end of the bed, a ¾ in. bolt passing through the outer holes in the handle and through the two holes in the bed, one of which is shown as E. There are two of these holes, one in each flange of the channel. The roller occupies the other two holes in the fork of the handle. The ¾ in. bolt

forms a pivot for the handle to operate up and down for bending the bus-bar. In operation, the roller rolls over the copper bar and forms it to the proper bend. Very little force need be exerted to make perfect bends.

So. Bend, Ind. CHARLES A. PETERSON.

Practical Problems in Packing

NOTHING LOOKS more disreputable around a power plant than a lot of leaky pistons and glands and steam lines with small leaks here and there. These conditions often reflect on the ability of the engineer who maintains the equipment, but often there are conditions of operation that are unfavorable and for which the engineer in charge is not to blame.

Success in packing problems seems to depend on three things, viz.: 1st, The selection of the proper packing to fit the conditions; 2nd, The condition of the apparatus to be packed should be reasonably perfect; 3rd, Methods of applying packing should be correct.

The writer's experience with packing dates back to about 50 yr. ago when he was for a short time apprenticed to an old Irishman who ran a pumping station. This old man used to make his own packing for the rods of his cold water pumps. He would place a large roll of flax fiber in an iron kettle with about equal parts of tallow and bee's wax and heat it till the fiber was thoroughly impregnated with the lubricant. Then he would plait the fiber into shape to fit the various stuffing boxes. This packing was very satisfactory. A brass rod would take on a polish like a looking glass when this packing was used. The packing resembled what is now sold as square flax packing.

Of course nowadays there are brands of packing made to fit every kind of service. From this old man I learned that one should not tighten up a gland too tight, so as to not produce any friction to heat the packing; not at first to fill the stuffing box too full, if necessary put in another ring later; to let the packing leak a little at first if packing against steam and take it up a little later as the packing got set to the box. If packing against water it is always wise to let it leak a little as this always shows that the packing is not too tight. Short life of the packing is often caused by adjusting it too tight and causing unnecessary friction. Ring packing that has considerable rubber in it is likely to swell up when it gets hot, so must be left rather slack at first.

All flange steam packing should first be tightened up when cold, but must also be gone over again, as the steam pressure begins to raise and the parts get heated. But bolts should not be pulled up with full steam pressure on as there is danger of a flange cracking and some one getting scalded. This is also true of hand-hole and man-hole gaskets of a boiler.

By selection of proper packing I refer to the fact, for instance, that while red rubber sheet packing may be used for low pressure flange packing, a special high pressure asbestos sheet is used for high pressure and high temperature steam, and for extra high pressures and superheated steam, corrugated monel metal gaskets or some other form of metallic packing may be used. A different sort of pump plunger packing is used for handling cold water and hot water. In packing the plunger of a hot water pump an apprentice if uninstructed will often tighten up the packing too much and the packing swells up and stalls the pump when the hot water strikes it.

Of late years metallic packings have come into use and if properly applied they will not wear the rod as fast as will fibrous packing.

There are, however, several points to be considered before deciding to use fibrous or metallic packing on the piston rod of an engine. A preliminary examination should be made to see that the engine is perfectly in line as metallic packing does not perform so well if the conditions are adverse.

I refer to such things as the piston being "down," occasioned by undue wear, in which case the rod will not run true through the stuffing box. Of course if it is a Corliss type cross-head with adjustable shoes top and bottom the piston rod may be maintained central at the cross-head end of rod; and if the piston-head has a Corliss type adjustable bull-ring, the proper adjustment may be made to keep the piston rod practically central at all parts of its travel. Better yet, if the engine be an expensive one with a tail-rod and adjustable crosshead, the rod may be adjusted perfectly central so that the problem of packing the rod becomes simple. Metallic packing when used under perfect conditions is very satisfactory indeed and will remain tight for long periods with little attention but should be taken out and inspected say at intervals of six months as some of the springs may have become broken or lost their tension or the rings may have become brass bound and need relieving.

Some of the things militating against success in keeping flanges packed are: Changes in temperature in steam lines that carry pressures sometimes being hot and sometimes cold. These temperature changes are hard on the packing. Steam lines not properly supported or on a strain cause stresses on the flanges that make them hard to pack. I once had a case where the flange just above a boiler was constantly springing a leak, on taking it apart we found the boiler had settled, causing a strain on this fitting. Caustic soda, when used as a boiler compound, will often prime over and has a bad effect on engine packing. Also alkaline boiler compounds often eat out the packing at handhole plates and cause leaks. Many kinds of packing stay tight when steam is on the boiler, but when the boiler is cooled down and then fired up again begin to leak. This is peculiarly true of lead gaskets when used.

A high speed engine showed a tendency to get hot in the piston packing. We found eventually that the trouble was not in the packing but was because the piston was "down" and the rod was riding on the gland which was too snug a fit. This was remedied by boring out the gland a little larger.

When piston packing begins to leak and it has been in place a long time and lost its resilience, often the engineer will get a hot box and score the rod if he attemps to tighten it up. It is better to take no chances but renew the packing.

There is a slightly different problem encountered when one goes to pack a rod that revolves like a centrifugal pump. Here it is important not to pack too tight or the packing will sometimes stick to the shaft and revolve with it and get a sudden hot box. With a centrifugal pump operating on a high lift a small air leak will often cause the pump to drop its suction if the

stuffing box is not equipped with a lantern to keep water pressure from an outside source in the gland so that any leakage will be water leakage and not air leakage. I once ran across a case where a centrifugal pump was sent to an old time engineer to be used on a 16 ft. lift. He did not have it piped right and had so much trouble with it that he depended on another pump for the service. On looking it over I saw no reason why it would not work. I piped a water seal to it and it worked perfectly.

Packing jobs may seem only small jobs but still there are many technical points to be observed to get the very best results. OLD TIMER.

Chicago, Ill.

Reverse Phase Relays and Elevator Practice

WILL YOU KINDLY answer the following questions regarding elevator operation?

1. What is a reverse phase relay as applied to elevators? What is its use?
2. Are all elevators equipped with such relays?
3. Is a direct current motor equipped with one?
4. What is a potential switch and what is its use on elevator circuits?

J. B. HEYWARD.

A. 1. A reverse phase relay, as its name implies, is a relay made primarily to protect against reversal of phase rotation which, in the case of elevator motors or any other motor, would cause reversal of motor rotation. Such relays also operate if one phase fails when the motor is stationary. Their chief application is to motors operating elevators, hoisting and conveying machinery, machine tools and textile machinery.

Reversal of phase rotation, usually caused by reversal of wires in a polyphase circuit, while not of frequent occurrence, is liable to occur at any time where lines are being changed or repaired. The reverse current relay closes its contacts upon phase reversal and may thus be applied to prevent the starting of polyphase motors or to disconnect those already running upon the occurrence of phase reversal.

2. All elevators operated by polyphase motors should be equipped with reverse phase relays.

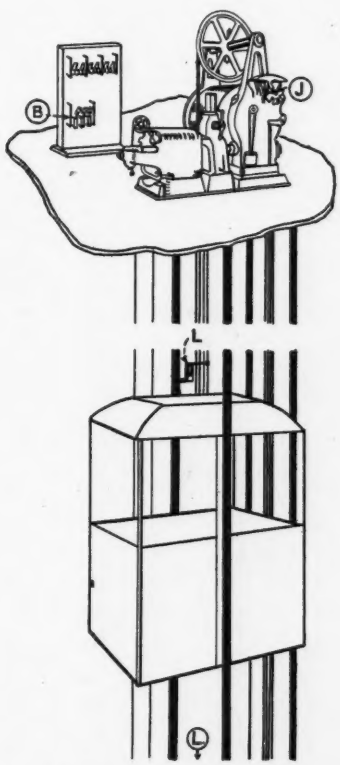
3. Direct current motors are not protected by reverse phase relays since "phase" has no significance in direct current circuits.

4. The potential switch, as referred to in elevator practice, is a switch which opens to cut off the power to the motor and applies the brake in case the car tends to overtravel at either the top or bottom of the hoistway.

In ordinary practice, in order to connect the operating switch in the car to the controller, a flexible cable runs from the car to a junction box halfway up the hoistway. This gives a flexible connection that allows the car to travel the full length of the hoistway. From this junction box the wires generally lead to the controller in metal conduit.

On the machine shown in the accompanying sketch, there are two sets of limits. One of these is at J and consists of a number of contactors opened and closed by cams operated from a traveling nut on the end of the drum shaft. The second set is the hatchway limit switches located at L near the top and bottom landings. One set of contactors located at J are the first to open, as the car approaches the terminal landings, and interrupt the circuit to the direction switch, which should cause this switch to be opened and the car brought to rest by applying the brake.

If for any reason the direction switch did not open and the car continued in motion, a second set of contacts would open shortly after the first and open the coil circuit to the potential switch B and cause it to open. This would cut the power out of the motor and apply the brake. Should the drum-shaft limits be out of adjustment and allow the car to go by the terminal landing, then a cam on the car would strike one of the hatchway-limit switches L and open it. Opening the hatchway limit opens the circuit to the coil of the potential switch with the same effect as if it were opened from the drum-shaft limits.



Typical overhead installation of the drum type elevator machine showing the location of the potential switch. (See Fig. 8—P. 13—Electric Elevators, by Annett)

CONSTRUCTION of the first stage of Grand Coulee Dam was 69 per cent complete on January 16 with only half the allotted time elapsed. Favorable weather and a comparatively low flow in the Columbia River has permitted the work of unwatering the central section of the dam site to proceed at a rapid pace and this phase of the work now is almost a month ahead of schedule. Since the river was diverted in December efforts have been concentrated on completing the cross-river cofferdams to their full height and pumping the central section dry so that the final excavation may be undertaken.

New Equipment

Locating Buried Metal

A NEW INSTRUMENT, which, it is said, quickly locates buried pipes, cables, and other objects made of metal, measures their depth, and permits the rapid and accurate mapping of underground metallic systems, with their branches and supplementary equipment, has been announced by the Fisher Research Laboratories Sales Company, Board of Trade Building, San Francisco, Calif., and 45 Rockefeller Plaza, New York.

According to the announcement, this instrument, which is known as the "M-Scope," is of interest to all those who lay or use underground pipe or cable systems, or who excavate ground where such systems are located. By means of it, surveys can be made readily, records checked, and errors corrected. Lost lines, valves, manholes, etc., can be located. Unrecorded and illicit connections can be discovered.

The stealing of water, gas, and oil can be detected and stopped. Costly exploratory excavations can be avoided. Damage to pipes and conduits and to excavating machinery during excavating and ditching can be prevented.

The M-Scope consists essestially of two specially designed radio units, a transmitter and a receiver. For most services two men are required, one for each unit; for others, both units are handled by a single operator. No electrical contact with the object being sought or traced is required except when tracing a single member of a compact group of pipes or cables.

In using the assembled M-Scope to locate a buried pipe or cable line, the operator switches on the transmitter, puts on earphones connected with the receiver, and carries both units in the direction of the line, if this is known. As he approaches the line, the sound heard in the phones gradually increases and a needle on an indicator meter swings forward, both signals reaching maximum when the operator has crossed the line.

To trace the line, the transmitter is set on the ground directly above it, and the operator, carrying the receiver, follows the path along which sustained signals are received. Sudden increases in the signals mean additional metal—a valve, junction, etc.—just below. Sudden decreases mean that the line has turned aside or ended.

According to the Fisher Laboratories, practically all parts of the M-Scope are standard radio equipment and can be repaired or replaced by any competent radio man. Energy for both units is supplied by standard dry cells which last several months in normal service. Individual units weigh about 8 lb. each. The complete instrument in a carrying case weighs about 22 lb.

Variable Speed Transmission

A NEW TYPE of variable speed transmission has recently been placed on the market by Graham Transmissions, Springfield, Vt. This transmission in a compact housing approximately motor size, furnishes any desired output speed from half motor speed to zero and reverse. This wide range of speed is obtained through a single turn of a control wheel. The unit is self contained, running in oil, has only five major parts, and is simple in construction and operation. While dispensing with belts, and using metallic rolling contact instead, it still retains the load-limiting features of most belt-driven units; and goes still further, in that it supplies inherent overload protection, without damage to the transmission unit or connected equipment.

The transmission at present is available in three standard sizes with a range of capacity up to 7½ hp., and in two speed ranges, normal and extreme. Both units are available with or without geared heads. The normal range (4:1) is especially suited for constant-horsepower applications; whereas, the extreme range unit provides speeds down to zero and reverse. This transmission is being manufactured for Graham Transmissions by The Fellows Gear Shaper Co., Springfield, Vt.

FROM APPALACHIAN COALS, INC., come announcements that nut-slack coals from the Blue Diamond Coal Co.'s mine will soon be oil treated, the same as that from the Crown Mine has been during 1936. Also Ralph DuPree has been appointed as a sales executive working from the headquarters office in Cincinnati and three "cadet engineers" have been added to the organization to study the operation of stokers for household heating and other fuel problems in order to give better service to coal users. The appointees are R. L. Adair, Jr., a graduate of Georgia Tech, working from Atlanta, Ga.; Paul R. Hayes, graduate of University of North Carolina, working from the newly opened office in Spartanburg, S. C., with Roy Lott, assistant southern manager directing the work; Jack C. Hutchinson, graduate of the University of Tennessee, working from the Detroit, Mich., office under Joseph W. Hoffman, newly appointed district sales manager.

The purpose is to develop engineers to promote and extend the intelligent and economical use of coal. As one result it seems from field tests that uniform nut-slack of 1 in. or 1¼ in. size with a large proportion of nut and pea coal will give better all-around efficiency than any other size for household stoker operation.

Keckley Steam Trap

ADVANCED improvements in design, construction, operation, materials, installations and maintenance features are incorporated in the new Keckley Type B inverted bucket steam trap. With the entire working mechanism of the trap attached to the cover plate, which is mounted on the body at a convenient angle, the maximum accessibility is afforded without the necessity of breaking any pipe connections.

Positive alinement of the valve with respect to the valve seat is accomplished through a dual purpose fulcrum and valve retaining plate. The valve seat is applied to a bored recess in the cover casting and held rigidly in place against a seat gasket by a monel fulcrum plate stamping which is slipped over the valve seat shoulder and secured in place with three fillister head

screws. Since the fulcrum point for the lever arm, which carries the valve, is thus integral with the valve seat retaining plate and positioned by the seat, positive relation of the movable valve to the fixed seat is always maintained within extremely close limits.

The close position of the fulcrum hinge to the valve and the long lever arm give exceptional leverage and decisive movement of the bucket together with clear opening and tight closing of the valve. The valve and valve seat are of hardened stainless steel and the buoyant member is a one-piece, non-corrosive bucket reinforced with a non-ferrous counterweight at the bottom. The inlet is at the bottom, center of trap body while two outlets are provided at the top, one for vertical and the other for horizontal pipe connection.

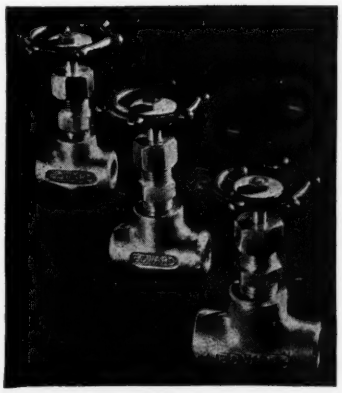
This trap is the product of O. C. Keckley Co., 565 Washington Blvd., Chicago, Ill., and is made in sizes from ½ to 1½ in. with capacities up to 32,000 lb. of water per hr. and pressures up to 300 lb.

NEW PAINTS developed by the Efkalin Co., 804 East 141st Street, New York City, have the property of changing color when exposed to heat. Some colors will turn back to original color when cooled, others will remain permanently changed. A series of five permanent changes and seven retroactive color paints are available. The former change at temperatures ranging from 300 to 734 deg. F.; the latter from 122 to 464 deg. F., with a safety margin of 25 deg. F. Each of the temperature changes is sharp and wide.

Permanent-change Efkalin require recoating after each change, while the retroactive ones are good for from 25 to 50 changes and, in some instances, for greater number before recoating.

New Edward Valves

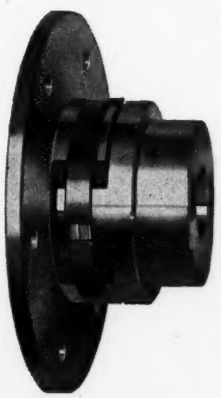
THE EDWARD VALVE & MFG. CO., INC., announces the redesign of its line of forged body gage valves. Outstanding features include new type tight-grip, unbreakable malleable handwheels of oversize dimensions and extra long taper-threaded bonnet joints. Backseating shoulders prevent hardened stainless stems from backing out and



allow repacking under pressure. Large stuffing boxes use distinctive Edward EValpak endless molded packing. Drop forged bodies preclude danger from seams and porosity and permit overstressing with safety. Working pressure ratings are from 4000 lb. at 150° F. and 600 lb. at 750° F. to 475 lb. at 1000° F. Available in sizes ⅛ in. to 1 in. in carbon and alloy steels.

Flexible Couplings

TYPE WF, a new type of flexible coupling made with one of the bodies in the form of a flange which bolts onto the flywheel, clutch or brake drum of a Diesel, gas or steam engine, has recently been



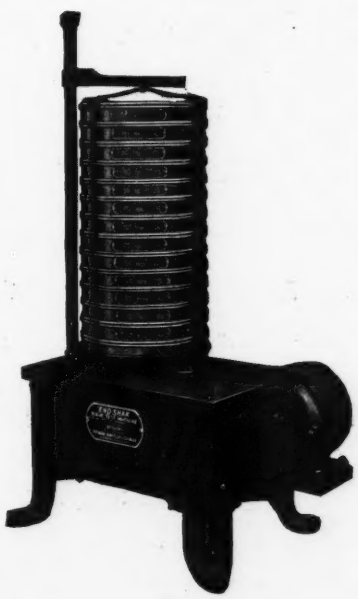
announced by Lovejoy Tool Works, 5009 W. Lake St., Chicago. The flange design reduces the overall length by one-third. A recently installed WFR-800 coupling capable of carrying a load of 324,000 in. lbs. extends less than 6 in. beyond the rim of the flywheel. The new coupling will be made in sizes ranging from 3 to 14 in. bores suitable for 2500 hp. at 100 r.p.m.

Bowser Mir-o-meter

TO MEET the needs of industrial plants using oil and tar as fuels, the S. F. Bowser & Co., Inc., Ft. Wayne, Ind., has developed the Mir-o-meter, a system which measures, indicates and records the quantity of oil or tar being delivered to the furnace. A displacement rotor in the meter is direct connected to a tachometer generator. The meter and generator can be installed wherever desired and the indicator and indicator recorder placed at points up to 750 ft. from the generator. The registering meter is the well-known Bowser Figure 760 that successfully handles liquids with viscosity ranges from 400 to 10,000 sec. Saybolt Universal at operating temperatures from 50 to 250 deg. F. and flows from 100 to 500 gal. per hr.

Sieve Shaker

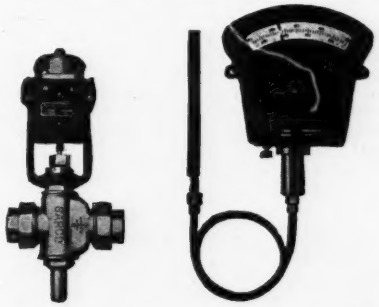
THE NEWARK WIRE CLOTH CO., Newark, N. J., now announce a new End-Shak testing sieve shaker for testing fine materials. The new shaker is provided with a simplified hold-down device, which permits the sieves to be easily and quickly put in place and removed, regardless of the number of sieves used. The combined reciprocating and turning motion of this shaker is an outstandisg feature. In its development the methods employed and recommended by the Bureau of Standards in making standard cement tests were followed.



The entire machine weighs 145 lb., including the motor and auto-time switch. The shipping weight is 175 lb. It is 32 in. high and the base, overall, is 22 by 18 in. A standard ¼ hp. 110 and 220 volt, 60 cycle, 1750 r.p.m. motor is used; but special motor equipment is furnished if desired. The standard auto-time switch automatically controls the period of the test. The End-Shak machine is designed for 8 in. diam. testing sieves and is adjustable to hold any number of sieves from 1 to 13, inclusive.

Electric Temperature Controls

SARCO CO., INC., 183 Madison Ave., New York, announce the completion of a new line of electric temperature controls for heating, air conditioning, refrigeration,



and industrial processes. These developments are based on patents and designs Sarco has acquired from Wilbin Instrument Corp., which has been liquidated. The new line includes line voltage thermostats, ranging from simple room types to multiple switch dial thermometer thermostats for the most exacting industrial requirements. Included also are hydraulically operated motor valves for steam, gas, oil, water, brine, or freon.

Nickel Cast Iron Uses

FOR POINTS in power plant equipment, where service is severe, nickel cast irons are widely and increasingly used. Examples run from nickel-chromium cast iron grate bars of the A. B. C. Grate Bar Works Co. up through the plant to smoke and dust precipitation valves and fittings of white nickel cast iron made by Frederick Iron and Steel Co. and nickel cast iron parts for flexible couplings of the American Flexible Coupling Co. In the boiler room are used coke crushers with Ni-Hard chilled iron segments from Robins Conveying Belt Co., goose-necks of nickel iron for soot blowers of Diamond Power Specialty Co., Ny-Tensyliron in the body and cylinders of the flow meter agitator of Elgin Softener Co., nickel cast iron in working parts of vertical engines supplied for stoker drive by E. H. Wachs Co., burning heads and other cast parts of domestic stokers built by Link-Belt Co. Boiler feed pumps made by Allis-Chalmers Manufacturing Co. have casings of nickel-molybdenum iron and turbine casings of pumps by J. S. Coffin, Jr., are of 1 per cent nickel cast iron. For valves of Wm. Powell Co., to be pressure tight, nickel cast iron is used, also for corrosion-resisting valves Crane Co. Ni-Resist is largely used. In the prime mover field, besides the stoker-drive engines, rotary engines for oil well rig plants of the Beaumont Iron Works have cast parts of nickel iron, large steam turbine casings produced by Treadwell Engineering Co. are of nickel cast iron and the same kind of metal is used for working parts in Diesel engines of The Power Manufacturing Co., to give tightness and high resistance to wear.

In all these applications, the requirements are for high tensile strength, close hard metal that will be pressure tight and have high resistance to corrosion, wear, or both.

ELECTRICAL CONDUCTIVITY of Fire Streams is this title of a new Bulletin, Vol. XX. No. 1 just published by the Engineering Experiment Station, Purdue University, Lafayette, Ind.

Heavy Duty Wrenches

FOR HEAVY WORK on large nuts and bolts, Snap-On Tools, Inc., has brought out three special devices. For driving extra heavy sockets a special handle has a 1 in. square driver lug, with ratchet and 36-in. detachable handle, which may be locked into the ratchet head. Also a special heavy duty sliding bar and extension bars are offered, the former with 30 in. leverage, the latter in lengths of 8 and 16 in. All handles will fit the heavy duty sockets which come in sizes of opening from 1 7/16 to 3⅛ in. for ⅞ in. to 2 in. nuts.

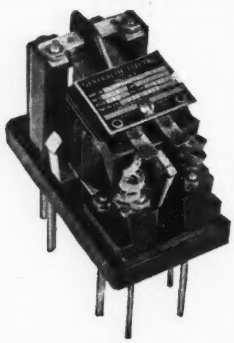
Boxockets for square or hex nuts are provided for heavy duty with straight or offset shanks in sizes 15/16 in. to 3½ in. opening, and having tubular handles in lengths 15 to 42 in.

For even heavier work, where it may be necessary to use a sledge hammer for tightening or loosening nuts, the hammer type of Boxocket wrench in sizes for hex nuts 1 7/16 in. to 4⅝ in. is specially designed. The wrench may be used direct, or with sockets in a like range of sizes to give an offset in difficult places.

New Auxiliary Relay

A NEW AUXILIARY RELAY, the HGA, that can both open and close a circuit and operates on either alternating-current or direct-current circuits, has been announced by the General Electric Company. The new relay is made in double pole arrangement, with either two or four contacts. It can be furnished with the operating coil for one to five amperes d-c; 6, 12, 24, 32, 48, 125, and 250 volts d-c; or 115, 230, 460 and 575 volts a-c. By adding an external resistor it can also be used on higher-voltage d-c circuits.

The relay is compactly designed and has both base and cover of black molded compound. The cover is held on by heavy spring clips mounted on the base, providing for ready removal or replacement. A glass window in the front is an optional feature.



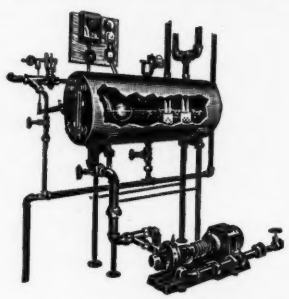
The stationary contacts are silver tipped and are doweled to the base to assure positive line-up with the moving contacts, while the latter, also silver tipped, are mounted on a molded carrier attached to the armature. This carrier is arranged to form a barrier between the movable contacts, increasing the striking distance. The contacts will make and carry 30 amp. for one minute of 12 amp. continuously.

All the parts in the magnetic circuit are made of silicon steel and are cadmium plated. In addition to the low residual provided by the silicon steel an air gap is introduced in the magnetic circuit by a small nonmagnetic shim to prevent sticking of the armature on residual magnetism.

An adjustable phosphor-bronze spring aids the weight of the armature in providing pressure os the normally closed contacts. The relay is back connected with contact studs of sufficient length to mount on panels up to two inches in thickness.

Return-to-Boiler Systems

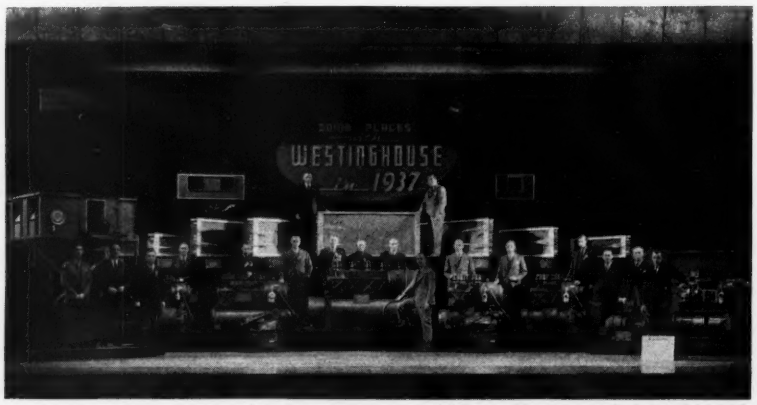
AN IMPROVED construction of Kisco Return-To-Boiler Systems has been announced by the Kisco Boiler & Eng. Co., 4333 Duncan Avenue, St. Louis, Mo. This is an improved method of returning condensate to the receiver as it has been found that when hot condensate is discharged on top of the water in the receiver considerable loss occurs through flash and vent. To prevent this, a submerged tube method,



called the Economizer, is being used to return the condensate below the water line. As an additional safety factor in the operation of Kisco Systems, a secondary switch is assembled in the receiving tank, which starts the motor and pump, and sounds an alarm in the event the condensate rises too high. This switch, which is called the Double Checker, is in addition to the Master Switch assembled in the boiler to regulate the boiler water level.

Westinghouse Air Conditioning Distributors Meet

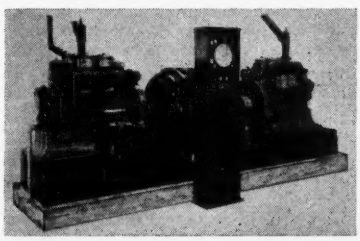
APPROXIMATELY ten tons of equipment was put on the stage at one time when Westinghouse held its Air Conditioning Distributors meeting at Mansfield, Ohio, Dec. 14 and 15. Left to right are the men who took a prominent part in the meeting: C. E. Badger, Mansfield Works; W. E. Minkler, Mansfield Works; L. A. Huggins, Mansfield Works; F. R. Reynolds, Philadelphia Office; H. F. Bullock, St. Louis Office; G. Berg, International Co.; H. F. Hildreth, Central District Office; C. Heilig, Canadian Office; F. W. Jordan, San Francisco Office; S. F. Myers, Mgr. Air Conditioning Sales; S. G. Yaney, Atlanta Office; E. P. Renouf, Dallas Office; F. D. McCann, New York Office; C. A. Rodman, Birmingham Office; W. C. Goodwin, Mansfield Works; R. C. Bonthron, New York Office; C. N. Bowles, Chicago Office; D. M. Ransay, Boston Office.



Automatic Diesel Plants

THREE standardized units for automatic Diesel electric plants have been developed by the Thermal Engrg. Co., 716 Columbus Ave., Boston, Mass., in sizes 45, 90 and 140 kw., each unit consists of one double-ended 1200 r.p.m. generator driven by two Diesel engines through automatic over-running clutch couplings.

A dual type air operated "Tecomatic" exhaust temperature recorder-controller is furnished for each double-ended unit. This provides for complete automatic control as well as a daily recorded log of each engine operation. This

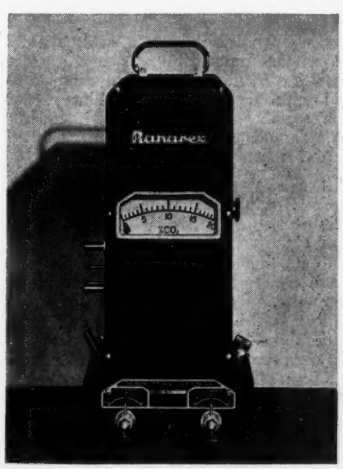


control starts and stops an adjacent engine on an increase or decrease in the load above or below the capacity of its respective engine, thereby resulting in increased efficiency due to high load factor.

Any number of these units can be operated in parallel and, therefore, a multiple unit plant of any capacity can be assembled. They can also be applied to automatically balance steam driven power plants. In multiple unit alternating current application the generators float on the line as synchronous condensers when not operating as generators.

Portable Renarex Co2 Indicator

THE PERMUTIT CO. of New York announces a portable CO_2 Indicator marketed under the tradename "Ranarex," which determines the CO_2 percentage continuously by a mechanical principle, based on the fact that the specific weight of flue gases varies with changes in the CO_2 content. This principle has been well proven by Ranarex CO_2 Recorders long in use in both stationary and marine steam power plants. In order to obtain a substantial force as a means of measuring the specific weight of the flue gas, a rotating motion is imparted to the gas by means



of a motor-driven fan revolving in a chamber. This fan blows the gas against the blades of an impulse wheel, thus producing a torque on the shaft of the impulse wheel in proportion to the CO_2 content. Changes in fan speed, temperature, humidity and atmospheric pressure are automatically compensated for by a comparing torque produced on another impulse wheel by air to which a rotating motion is imparted is a second chamber by a second fan driven by the same motor. The two impulse wheel shafts are coupled together by means of a balancing linkage actuating the indicator, the scale being calibrated in terms of per cent CO_2.

A New Adsco Product

CONDUIT of a new type for underground steam and hot water lines known as ADSCO-Bannon Tile Conduit is being placed on the market by the American District Steam Co., North Tonawanda, N. Y. This conduit is simple in design and is easily installed at low labor cost. It consists of a substantial base drain tile

supporting a circular, salt glazed, vitrified tile conduit. The tile conduit, with bell and spigot joints in approximately 2 ft. lengths, is separable on the job into two halves along the horizontal center line with a resulting diagonal fracture. The bottom half of the conduit is placed on the base drain, the joints mortared and the trench backfilled to approximately the top of the half section of conduit.

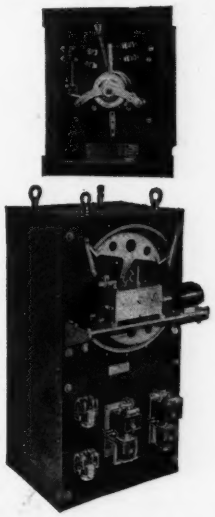
One or more pipes can be installed, tested, inspected and insulated with standard insulations before the top half of the conduit is placed. The top and bottom halves of the conduit are sealed with mortar in the ball and spigot joints and between the projecting outside lips on each side of the conduit, then the trench is ready for backfill. ADSCO-Bannon Tile Conduit is available in various sizes to accommodate one or more pipes, with or without insulation. Sectional asbestos or any one of several filler types of insulation, such as rock wool, can be used in the conduit.

Rheostatic Generator Voltage Regulator

ALLIS-CHALMERS MFG. CO., Milwaukee, Wis., has recently placed on the market a new line of larger rocking contact voltage regulators, designated as type "J". They have been especially designed and developed for the control of large and important synchronous machines where high speed of voltage recovery, accurate voltage control and reliability are essential. In modified form they can also be obtained to control large direct current generators.

The design incorporates high speed features as well as the very successful time-proven rocking contact principle used in Allis-Chalmers' existing lines of voltage regulators. The two main parts of the complete regulating equipment consist of the voltage control element and the rocking contact motor operated rheostat with high speed contactors and relays. The voltage control element is connected to the machine to be regulated through suitable potential transformers and operates its contacts when the voltage differs from the normal value. The rocking contact motor operated rheostat is the means for varying the machine field current and adjusting it to the correct value to give normal generator voltage by acting in the exciter field circuit.

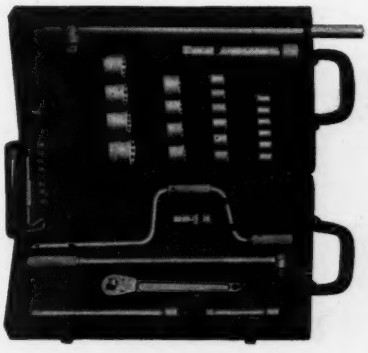
The major element of this equipment is the rocking contact motor operated rheostat with high speed contactors and relays, all as shown in the illustration. This rheostat is constructed on a larger



scale than employed in the standard regulators and provides a greater number of steps that are of higher current carrying capacity. When the voltage of the synchronous machine is normal, the entire regulating equipment is at a standstill, thus assuring a minimum amount of wear with practically no renewal or maintenance expense.

Wrench Set and Cabinet

FOR CONVENIENCE of engineers and master mechanics, Snap-On Tools, Inc., has brought out its Master Mech Socket Wrench Set with midget units for small work and thin walls for close places, also heavy duty sockets, with sliding and extension bar, a ratchet handle, a brace and universal joints for working at angles. These cover sizes from ¼ in. to 1 5/16 in. hexagon nuts, and U. S. S. nuts ⅜ in. to 1 in., S.A.E. sizes ¼ in. to 1⅛ in. thread diameter and U. S. S. cap screws ⅜ in. to 1¼ in. All are arranged in a compact metal cabinet, convenient for keeping the tools in place and for carrying to the job.



Henry Vogt

HENRY VOGT, 80, founder and president of the Henry Vogt Machine Co., of Louisville, Ky., died at 8:30 a. m., Sunday, December 27. He had been ill a week with a heart ailment.

Mr. Vogt was a native of Louisville and educated in the public schools. After serving as a machinist's apprentice he opened a small machine shop for general repair work and the manufacture of elevators in 1880. A foundry and boiler shop

were added to the plant a few years later. The Vogt absorption refrigeration machine was developed and placed upon the market at this time with signal success and the manufacture of equipment for oil refineries was begun. In 1911 drop forged steel valves and fittings for high pressure and high temperature applications were added to the firm's products, all of which today enjoy a world wide market.

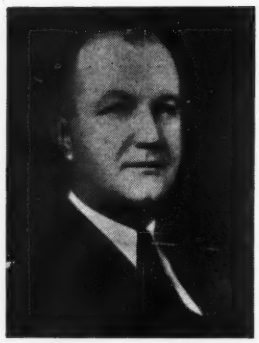
A charter member of the A. S. R. E. and active in the N. A. P. E., Engineers and Architects Club, Louisville Board of Trade, Rotary Club and Audubon Country Club, Mr. Vogt was also actively identified with numerous civic and philanthropic organizations of the city and state of his birth.

The James F. Lincoln Arc Welding Foundation

DEDICATED to encouragement of study and research for benefit of the arc welding industry, a significant new Foundation has just been established by vote of The Lincoln Electric Company's directors.

This new fund has been named "The James F. Lincoln Arc Welding Foundation," in honor of the pioneer work of the company's president in promoting arc welding and in perfecting and developing arc welding equipment and electrodes. One of its primary functions will be the stimulation of original design in order that arc welding processes may be more widely utilized in modern-day fabrication.

Principal direction of the Foundation's work will be given by Dr. E. E. Dreese, head of the Department of Electrical Engineering at The Ohio State University. Other trustees who will serve with Dr. Dreese on the Foundation are W. B. Stewart, distinguished member of the Cleveland Bar, and H. R. Harris, Vice-President of the Central National Bank of Cleveland.



Dr. Dreese is a member of the American Institute of Electrical Engineers, and has wide connections in the field of general science. His position with the Foundation assures the carrying out of studies which will view arc welding with full regard to both its economic and social significance.

J. I. Robinson

J. I. ROBINSON, on January 1 succeeded J. Austin Murphy, who has retired from active service after 51 yr. with the company as Vice-President of Crane Limited, Canada.

Mr. Robinson joined Crane Co. in 1907 in the San Francisco branch. In 1919,

when the company started its Canadian expansion, he was transferred to Montreal where he worked his way up to the position of Director and General Sales Manager. From this position he now steps up to the office of Vice-President with complete supervision over Crane Limited and its subsidiaries.

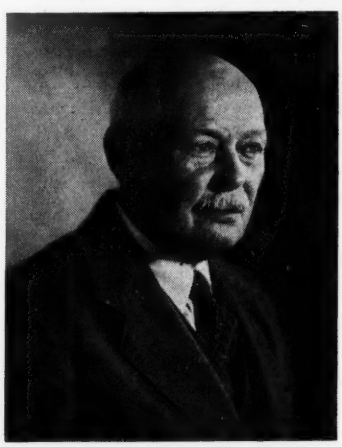
Albert W. Strong

ALBERT W. STRONG, 64, president of The Strong-Scott Mfg. Co., Minneapolis, Minnesota, died at Northwestern Hospital November 25th, following an abdominal operation. Mr. Strong had been President of the Company for 39 yr. since its incorporation. Most of his time since 1924 was devoted to the development of fuel-burning equipment, particularly unit pulverizers, and he was primarily responsible for the position the Company now holds in the field of combustion engineering. As a pioneer manufacturer of grain and milling equipment in the Northwest, his death closed a career of prominence in business, social, civic and benevolent affairs. The business will be carried on without interruption by Mr. Strong's two sons, Lucian S. Strong and A. W. Strong, Jr., the former succeeding his father as president.

J. F. Max Patitz

J. F. MAX PATITZ, chief consulting engineer, Allis-Chalmers Mfg. Co., Milwaukee, Wis., died suddenly of a heart attack January 3, 1937. He was associated with Allis-Chalmers for more than 51 yr., over half of which he served as consulting engineer.

Mr. Patitz was born at Mugeln, Saxony, in 1866, and entered the employ of the E. P. Allis Co. in June, 1885. He was soon transferred to the engineering department, and in 1901 when the E. P. Allis Co. became part of the Allis-Chalmers Co., he was placed in charge of the building of steam engines and compressors. In 1902 he was sent abroad to investigate the existing steam turbine types and on his return did much to further the building of



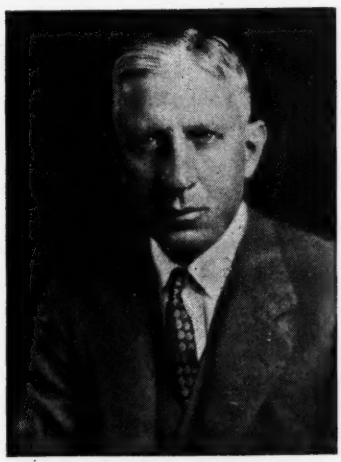
steam turbines by the company. Mr. Patitz, from time to time, made other trips to Europe, on behalf of his company, to investigate designs of gas engines, Diesel engines, compressors, tillers and tractors.

Mr. Patitz was granted many useful patents. His studies of parallel operation of alternating current generators began as early as 1900. His studies of critical speeds and of vibrations in high speed machines were outstanding and he was an authority on intricate mathematical calculations connected with the design of machinery. He was a member of the A. S. M. E., the S. A. E. and the Verein Deutscher Ingenieure.

ANNOUNCEMENT has been made by U.S. Rubber Products, Inc., 1790 Broadway, N. Y., of the U. S. Royal Asbestos Cord Steam Hose Official P-6031, a new addition to its line of steam hose. This hose has a non-deteriorating, non-char carcass, is adaptable to superheated high pressure (200 lb.) steam service, is light in weight and flexible. The hose is constructed of quality steam and heat-resisting rubber tube; four plies of high strength asbestos cords wound spirally in alternating directions; cords cushioned in a layer of rubber and wrapped in a heat-resisting rubber cover.

R. B. Howland

R. B. HOWLAND has been elected Vice-President and a Director of United Engineers & Constructors, Inc. Mr. Howland is a graduate of Drury College A.B. 1906 and Purdue University B.S. 1910. Previous to graduation from Purdue he was employed by the United States Steel Corporation at Gary and South Chicago. In 1918 he joined the Stone & Webster organization and was assigned to hydro-electric construction near Seattle. In 1912 Mr. Howland was transferred to Keokuk, Iowa, where he became General Superintendent of the Mississippi River Power Co. in 1919. During the war years he was Superintendent of Power and Compressed Air Construction and Operation at the Hog Island Shipyard.



In the fall of 1919 Mr. Howland became associated with Dwight P. Robinson & Co. in New York, and during a period of 9 yr. participated in the engineering and construction activities of that firm. When in 1929 Dwight P. Robinson & Co. was merged with three other nationally known engineering organizations to form United Engineers & Constructors, Inc., Mr. Howland became Assistant to the President and has held that position up to the present time.

Edison Medal to Alex Dow

ALEX DOW, president, Detroit Edison Company, has been awarded the A.I.E.E. Edison Medal for 1936. The medal is awarded annually for "meritorious achievement in electrical science, electrical engineering, or the electrical arts," will be presented to Doctor Dow during the Institute's winter convention at New York, N. Y., January 25-29, 1937.

Doctor Dow was born in Glasgow, Scotland, in 1862, and although he is not a graduate of a technical school, he has received the honorary degrees of master of engineering and doctor of engineering from the University of Michigan and doctor of science from the University of Detroit.

During the period 1874-82, he was employed as junior clerk and stenographer in a railroad office and in the offices of a steamship company in Liverpool, England. In 1882 he came to the United States, and was employed in various departments of the Baltimore and Ohio Railroad Co. Later he was transferred to the Baltimore and Ohio Telegraph Co. to take charge of local line and instrument maintenance, with some construction and experimental work on telephones. In 1888 he was employed by the Brush Electric Co., Cleveland, Ohio, as installation electrician in the Chicago office, becoming district engineer in that office in 1889. In 1893, he accepted the opportunity to design and supervise the construction of the original public lighting plant of the city of Detroit, and in 1896 he became vice-president and general manager of the Edison Illuminating Co. of Detroit. This company was succeeded by the Detroit Edison Co. in 1903; and Doctor Dow was retained as vice-president until 1913, when he was made president.

He became a naturalized citizen in 1895. Doctor Dow has been a leading pioneer in the United States in the engineering, rate making, and general operation of the electric light and power utility, and is given credit for both the engineering and financial success of his enterprises. He has supervised the design and construction of several generating stations of the Detroit Edison system, and he is called the father of the so-called "big" steam boiler in the United States, having installed 2350-hp. boilers at a time when 600- to 750-hp. units were commonly considered large. He was the first to adopt the underfeed stoker for large installations, and much of the earlier development of this type of equipment was made in his power plants. In addition to his electric utility activities, Doctor Dow served the city of Detroit as the engineer member of the Board of Water Commissioners from 1916 to 1921, and again from 1925 to 1927.

Fuel Engineers' Meeting

ON JANUARY 11 more than 100 fuel engineers and sales managers of constituent companies of Appalachian Coals, Inc., attended the Seventeenth Fuel Engineers' Meeting in Cincinnati, O. Principal speakers were Dr. Reinhardt Thiessen, research chemist, Pittsburgh Experiment Station, U. S. Bureau of Mines; J. J. Brennan, research engineer, Northern States Power Co., Minneapolis; R. M. Hardgrove, engineer, The Babcock & Wilcox Co., New York City; E. P. Ogden, consulting ceramic engineer, Columbus, O.; and E. L. Greever, attorney, Tazewell, Va. J. E. Tobey, manager, fuel engineering division of ACI, who arranged the program, presided at the conference.

"What Is Coal?" was the question answered by Dr. Thiessen, who has spent more than 25 years in studying the paleobotany of coal.

"Coal is a complex substance," said Dr. Thiessen, "consisting of many different constituents, representing many chemical compounds, very few of which are known. In the study of coal, it is of the utmost importance to study and to know not only the plants contributing but also the manner in which deposits are formed out of them." His discussion gave the scientific reasons why coals from one section of the country differ widely from products mined in other areas.

"The Fusibility of Coal Ash," the paper presented by Mr. Brennan, dealt with the "difficulties experienced as a result of slag and clinker formation when burning coal in furnaces of modern steam plants." The speaker, who said that his paper was prepared with the assistance of his associates, D. F. Mitchell, F. P. Tierney, and W. C. Thompson, emphasized the "necessity for the development of laboratory methods to aid in the selection of coal most suitable for use on particular types of equipment."

He also presented a brief description of what he called "the standard method for the determination of the softening temperature of ash" and the results obtained with another method which he has found useful in classifying coals according to their slag forming and clinkering characteristics.

"Grindability of Coal from the Producers' Viewpoint" was the subject of Mr. Hardgrove's paper. He stated that the "coal producers should be actively interested in knowing the grindability of their coals, as well as competing coals." He reported that a thorough knowledge of grindability and its effect on the capacity of various types of pulverizers would help to prevent the "placing of coals in plants which have insufficient pulverizer capacity."

Mr. Ogden's paper, "Problems in Firing Industrial Kilns," concerned the fundamental principles and conceptions of the firing of ceramic products. He stressed the fact that firing is "an important step in the manufacturing process and not at all a simple question of raising a piece of ware to a given temperature in the shortest possible time."

Anniversary at Johns Hopkins

RECENT PROGRESS in power development will be the subject discussed by Prof. A. G. Christie of the Johns Hopkins School of Engineering at the technical sessions on February 20, planned as a part of the three-day celebration of the twenty-fifth anniversary of the School.

The anniversary program will begin on February 19 with the opening of an Engineering Show on the Homewood campus. The principal event will take place on February 22 at 11:00 a. m. when Dr. Karl T. Compton, president of the Massachusetts Institute of Technology, delivers an address at the sixty-first Commemoration Day exercises of the University. At the Alumni Dinner that evening, Abel Wolman, chief engineer of the Maryland State Department of Health and chairman of the Water Resources Committee of the National Resources Committee, will be the chief speaker. Mr. Wolman received his B. S. in Engineering at Hopkins in 1915.

Professor Christie has been associated with the development of power plants and equipment for the last 35 yr., having served as consulting engineer on power problems in this country, Canada and abroad. He has made an extensive study of the present status of foreign power development and will summarize his conclusions in his address. Five other leading members of the faculty will discuss current research problems in their respective fields.

Closely related to these topics will be the various departments of the technical exhibit. The hydraulics laboratory, the surveying and drafting rooms and the graduate research quarters may be inspected. Interesting experiments on the dielectric properties of oil-impregnated paper; methods for determining stresses and deflections on tubular steel bridge piles by means of a laboratory model; and the effect of lightning on modern power transmission lines will be demonstrated.

Actuated dioramas of slum clearance and flood control projects; industrial adaptations of research laboratory processes; a model of a coke oven battery; and experiments on the magnetic testing of steel instruments, the removal of sulphur from gases, and the improvement of domestic oil burners may also be observed.

News from the Field

ANNOUNCEMENT has been made by Johns-Manville of the promotion of four officials to new executive posts following the resignation of E. M. Voorhees, as secretary and treasurer, in order to accept the position of vice-chairman of the finance committee and a director of U. S. Steel Corp. Charles H. Roberts goes from general auditor to comptroller; Arthur Olsen, who joined the company on January 1, is to be treasurer; Vandiver Brown steps from assistant secretary to secretary; and W. I. Waite has been made secretary of the officers' board.

MODERNIZATION of the Des Moines Railway Co., Des Moines Ia., power plant by means of a superposed turbine installation is proceeding rapidly. The new section is designed to be separate from the existing equipment insofar as possible and will carry the major portion of the load. The first unit will consist of a 1000 kw. G.E. non-condensing turbine, exhausting at 165 lb. gage pressure and driving a 4400 v., 3 ph., 25 cycle generator.

Steam will be supplied by 100,000 lb. per hr., 450 lb. gage, 100 deg. superheat B. & W. boiler, equipped with economizer, air preheater and soot blowers and fired by a Westinghouse underfeed stoker. The boiler will also have Bailey combustion, feedwater, pressure reducing and desuperheating control, one Clarage forced draft fan and one Prat-Daniels induced draft fan and stack.

Two Allis-Chalmers 212 g.p.m., 485 lb. boiler feed pumps, one dual driven and one motor driven, will be installed, the dual driven unit to be controlled in accordance with the heat balance requirements. Feedwater requirements will be taken care of by a 180,000 gal. Cochrane heater and 2000 lb. per hr. evaporator.

The Federal Engineering Co., of Davenport, is doing the engineering work.

NATIONAL POWER CONFERENCE has planned the first of a series of five meetings covering important and specialized power subjects to be held at the Hotel La Salle, February 16, all day. The morning session will be devoted to "Planning Mechanical Distribution of Power" and the evening session will be a continuation but covering "Planning Electrical Applications of Power". The third session will cover the power plant as an "Asset or Detriment".

AMERICAN CHAIN & CABLE Co., Inc., is the new name of an old company, known previously as American Chain Co., Inc. Long recognized as a leading manufacturer of chains for all purposes, the American Chain Co. has since 1924 become prominent also in the production of wire rope or cable for all purposes. It was this fact which caused the directors of the corporation to enlarge the name to American Chain & Cable Company, Inc. In addition to chain and wire rope, many other essential products are manufactured by the following divisions and associates of American Chain & Cable Company, Inc.: American Chain, Andrew C. Campbell, Manley Manufacturing, Page Steel and Wire, Wright Manufacturing, American Cable, Ford Chain Block, Hazard Wire Rope, Highland Iron & Steel, Owen Silent Spring, Reading-Pratt & Cady and Reading Steel Casting. The directors recently elected W. B. Lashar chairman of the board; W. T. Morris, president; Wilmot F. Wheeler, executive vice-president and treasurer; A. P. Van Schaick, vice-president in charge of sales; C. G. Williams, vice-president in charge of production; W. M. Wheeler, secretary; Frederick C. Geier, assistant secretary, and Stanley Mann, comptroller. The general executive offices will remain at Bridgeport, Conn., and 230 Park avenue, New York City. Manufacturing plants are located at Bridgeport and Hartford, Conn.; York, Reading, Monessen, Braddock and Wilkes-Barre, Pa.; Adrian, Mich., and Terre Haute, Ind.

CATERPILLAR TRACTOR Co. announces the appointment of Louis B. Neumiller as sales manager of its Central Sales Division. Edw. W. Jackson has been promoted to the office of general service manager, the position held by Mr. Neumiller prior to his advancement. H. M. Hale is sales manager of the Eastern Sales Division, H. H. Chambers of the Western Sales Division and F. G. Nunnelly of Canada. All of these men make their headquarters at Peoria, excepting Mr. Chambers, who headquarters at San Leandro, Cal.

THE NATIONAL INVENTORS CONGRESS has planned a conference and exhibit of new inventions to be held in the La Salle Hotel, Chicago, March 29 to April 2. Educational meetings will be held in the mornings, and the afternoons and evenings will be devoted to demonstrations of new inventions and new products.

AUTOVENT Fan & Blower Co. of Chicago announces the promotion of Tom Brown to vice-president and general manager, of George J. Kalwitz to general sales manager, of Robert F. Ruggles to eastern division manager. Also appointment of new representatives: Frank B. Nimmo, Minneapolis, Minn.; R. J. Engel, Appleton, Wis.; B. J. Doyle, Milwaukee, Wis.; Industrial Representatives, Peoria, Ill.; Allan T. Shepherd, Richmond, Va.; Engineering Sales & Service Corp., Louisville, Ky.; Harold M. Hudson, Seattle, Wash.

DAVID H. KELLY, manager of Allis-Chalmers Mfg. Co.'s district office at Philadelphia, died at his home in Penn Valley, Pa., on December 7. He was born in Steubenville, Ohio, in 1883, and graduated from the University of Illinois in 1904. Shortly after this he entered the employ of the Bullock Electric Mfg. Co. which later became part of the Allis-Chalmers Mfg. Co. He was appointed manager of the Philadelphia District office in 1920.

L. H. HILL, well known transformer engineer, has been appointed Engineer-in-charge of Allis-Chalmers Mfg. Co's. Transformer Division. He succeeds the late L. C. Nichols with whom he served as assistant engineer-in-charge since 1931. Until that time he was, for a number of years, Manager of the Transformer Division of the American Brown Boveri Company which was absorbed by Allis-Chalmers, and prior to that was associated with Westinghouse Electric and Manufacturing Company as transformer design engineer and as engineer-in-charge of power transformer development.

NEW YORK BELTING and Packing Co., announces the appointment of R. B. Moore, Bolivar, N. Y., with a branch at Bradford, Penna., as distributors of the complete line of the Company's mechanical rubber goods.

THE UNIVERSITY OF ILLINOIS announces the Fourth Short Course in Coal Utilization which will be held at Urbana on May 25-27, 1937. It is expected that a detailed program will be available for distribution about April 1. The 1936 course was attended by 232 coal men from 18 different states. Professor D. R. Mitchell, of the Department of Mining and Metallurgical Engineering, will be in charge of the course.

J. E. TOBEY, manager, fuel engineering division, Appalachian Coals, Inc., is the new chairman of the Ohio Valley Section, American Institute of Mining and Metallurgical Engineers, having been elected at the recent annual meeting held in Columbus, Ohio.

WORTHINGTON PUMP AND MACHINERY CORP. on January 1, 1937, absorbed its subsidiary, Carbondale Machine Corp., whose organization, products, and sales activities, will be continued as a division of Worthington.

WITH MARKED increases in electric and gas output, the operating companies in the Standard Gas and Electric Co. system are faced with a need for additional generating capacities and extensions to lines. The company's preliminary construction budget for 1937 will total $33,470,000 for operating companies in the system. This amount includes expenditures of $6,784,000 to complete construction work on projects now in progress. Of the total proposed budget of $33,470,000, the actual amount estimated to be expended during 1937 is $28,932,000, this indicating that $4,538,000 of the proposed budget for 1937 will be appropriated for projects which will not be completed during the coming year but which will continue on into 1938.

The total proposed budget provides for expenditures in the electric department amounting to $23,055,000 and in the gas, transportation, telephone, heating and other departments $10,415,000 has been appropriated. The amounts indicated are subject to final approval by the boards of directors of the individual public utility operating companies in the Standard Gas and Electric Co. system.

Year ending reports and forecasts for the new year now being prepared by the operating companies of this company's system indicate that definite improvement is taking place in general business conditions in the territories in which these subsidiaries operate. While at the present time the rate of growth of gross earnings of the various subsidiary companies is considerably retarded by rate reduction programs which have been instituted as a result of public demand, and while for the present operating expenses are showing a tendency to increase abnormally due principally to the ever mounting tax burden, it is to be hoped that both these handicaps will prove to be temporary in their nature and that continued improvement in business conditions will be fully reflected in the earnings of the operating companies.

Standard Gas and Electric Co. has been under Section 77B of the Federal Bankruptcy Act since September, 1935; however, definite progress is being made toward the reorganization of the company and it is hoped that a plan may be developed without undue delay for submission to the company's security holders.

FOSTER WHEELER CORP. announces the appointment of W. L. Martwick as General Sales Manager with headquarters at the New York office, 165 Broadway. Mr. Martwick has been with the organization since 1926, when it acquired the Aero Pulverizer Co., of which he was President.

CONSTRUCTION of a modern factory and office building for the Penn Electric Switch Co. is nearing completion at Goshen, Ind., where headquarters will be established about February 1, for the company's future operations, transfer of the business being made from Des Moines, Iowa.

Placed under contract about November 1 following the study of several sites submitted by The Austin Co., which designed and is erecting the buildings, the manufacturing plant—210 ft. by 340 ft.—has been under roof since December 1. Record speed in construction was achieved through the use of structural steel manufactured and carried in stock at the Austin fabricating shops in Cleveland. The plant and office building represent the latest trend in industrial design. Shafts of glass block which will rise to full three story height in the entrance tower of the two-story office building. It has 6000 sq. ft. of horizontal steel sash in one band enclosing the side walls between upper and lower bands of buff colored face brick and ornamental art stone. Monitors extending the full length of the plant will supplement daylighting and ventilation from the side walls.

The office building, 40 ft. by 112 ft., will be entirely air-conditioned and the entire factory building will be cooled in summer by fan units through which water will circulate at 53 deg. temperature. A boiler house, 30 ft. by 40 ft., adequate to meet the requirements in the event of future expansion, has been provided adjacent to the plant, which will be served by a switch track connecting with the New York Central Railroad.

The company anticipates a total employment of approximately 350 in the new Goshen plant, which will include complete research, development and testing facilities, stamping, machine and tool departments, as well as the most up-to-date equipment for manufacture and assembly of finished automatic controls.

T. A. MARSH, Central District Engineer for the Iron Fireman Mfg. Co., was selected as executive chairman of the Fuels Division of The American Society of Mechanical Engineers at the annual meeting. Mr. Marsh has served on this committee for a number of years and is well fitted to direct its activities.

LINCOLN ELECTRIC CO. has opened an office at 1015 Hanover St., Chattanooga, Tenn., with Robert Daniels in charge. Mr. Daniels has had 4 yr. practical experience as a welder, has been associated with the sales work of the organization since 1934 and is fully schooled in all the aspects of arc welding, as well as being a graduate mechanical engineer.

CITY OF CLEVELAND, O., has purchased three Stowe stokers for installation in the municipal light plant under 1400-hp. Connelly boilers, each stoker to have 350 sq. ft. of active grate area so as to operate the boilers at 300 per cent of rating. Changes have been made under the direction of Frank O. Wallene, Director of Utilities, and L. A. Quayle, Chief Engineer.

IN THE MODERNIZATION of its Schuylkill station, the Philadelphia Electric Co. is planning the expenditure of $5,000,000 during the next year. Two new boilers, each with a capacity of 600,000 lb. steam an hour at 1200 lb. pressure and 900 deg. F. are to be installed. They will supply steam for a new 50,000-kw. turbo-generator. The new unit will be superposed on the existing steam units and will discharge sufficient steam to operate about 60,000 kw. capacity of the existing turbo-generators.

HENRY C. CUMMINS, vice-president in charge of operation and engineering of Public Utility Eng. & Service Corp., 231 S. La Salle St., Chicago, Ill., announces the following appointments and changes in title among executives in the operating and engineering department of the organization:

E. D. Uhlendorf, executive engineer; F. H. Lane, manager, engineering division; A. H. Kuhn, manager, valuation division; G. E. Potter, assistant to executive engineer; W. B. Rittenhouse, assistant to manager, engineering division; W. C. Drummond, power production engineer; H. W. Eales, chief electrical engineer; H. S. Whiton, chief mechanical engineer; H. G. Robey, chief hydraulic engineer; L. J. Willien, chief gas engineer; W. J. Welch, chief design engineer; Stephen Wehner, hydraulic engineer; D. C. Hormell, mechanical engineer; H. O. Mathews, automotive engineer; J. A. Agee, budget control engineer.

INCREASED manufacturing facilities are provided by a new factory addition just completed by the Ajax Flexible Coupling Co., Westfield, N. Y.

ANNOUNCEMENT of the formation of the American Public Works Association, taking effect on January 1, 1937, was made by the American Society of Municipal Engineers and the International Association of Public Works Officials. This new organization is created by the consolidation of the members of the two present organizations as it thought that joining of their programs of activity will enable the new association to be of greater service to the public works profession. Headquarters of the American Public Works Association will continue to be at 850 E. 58th St., Chicago, Ill.

THE WM. B. PIERCE CO. announces the recent appointment of George C. Ewing, located at 10 High Street, Boston, Mass., as sales representative and distributor for the New England states. Mr. Ewing was for many years associated with the Westinghouse Electric and Manufacturing Co.

THOMAS J. DILLON, president, Edge Moor Iron Works, Edge Moor, Del., announces the appointment of Russell T. Kernoll as Chief Engineer of Welded Fabrication. Mr. Kernoll has had many years' experience in pressure vessel and welded equipment fabrication. He comes to Edge Moor Iron Works from the Engineering Department of M. W. Kellogg Company, Jersey City, N. J., and prior to this connection, had been for many years associated with Struthers-Wells Company, Warren, Pa., in executive and engineering capacities.

ANNOUNCEMENT has just been made by the Extension Division of the University of California, 301 California Hall, Berkeley, Calif., that the correspondence course in Diesel Engineering has been thoroughly revised and is now open for those who wish to enroll. The course presents a general discussion of the elements of the Diesel Engine so as to furnish the practical man with fundamental principles which will assist him in the operation and maintenance of the engine. The course is in fifteen assignments all fully illustrated by diagrams and blue-prints. The required fee for the course is $7.00 for students in California, or $10.00 for those enrolling from points outside California.

JOHN E. WRAY has been appointed Manager of Allis-Chalmers Manufacturing Co.'s district office at Philadelphia to succeed the late D. H. Kelly. He graduated frim Penn State College with the degree of electrical engineer in 1910, entered the employ of Allis-Chalmers as a student apprentice at their Bullock Works, then became connected with the West Penn Power Co. on construction work, but returned to the Bullock Works, later being assigned to the company's Cincinnati district office. Since 1919 Mr. Wray has been a sales engineer at the company's Philadelphia district office of which he has now been made manager.

DUE TO AN expansion program made necessary by an increased demand for the company's products and by the growing scope of the company's service facilities, the Crane Packing Co., Chicago, Ill., has moved its Houston, Texas, office from 911 Electric Building to 1303 Capitol St., where a new factory branch and warehouse has been established. This move to larger quarters has been carried out under the direction of Roy Blackbird, Manager in the southwest territory, who will be in charge of the new branch warehouse.

PIERCE T. WETTER, who for 10 yr. has been on the staff of the American Society of Mechanical Engineers supervising its technical professional division, has left the staff of the Society to become executive Vice-President of the American Cutting Alloys, Inc., of 500 Fifth Ave., New York City. Mr. Wetter also becomes Vice-President and Assistant Treasurer of the American Electro Metal Corporation of Lewiston, Me., manufacturers of molybdenum and tungsten products.

ALLIS-CHALMERS MFG. CO., Milwaukee, Wisconsin, announces that its subsidiary company, Condit Electrical Mfg. Corp. of Boston, Massachusetts, will be operated as a Company unit after January 1, 1937. After that date the plant will be known as Allis-Chalmers Mfg. Co. Condit Works. The address is 1344 Hyde Park Avenue, Boston, Mass.

The plant will continue to specialize in the manufacture of switchgear products as a division of the Electrical Department under Mr. R. S. Fleshiem, Manager. The personnel, with headquarters at Hyde Park, will be as follows: Mr. George A. Burnham, Assistant Manager of the Electrical Department in charge of Sales and Engineering of the Switchgear Division; Mr. W. S. Edsall, Manager of Sales, Switchgear Division, Mr. H. V. Nye, Engineer in charge of the Switchgear Division, with headquarters at Milwaukee.

The Works organization will be under the direction of Mr. Frank W. Young, Works Manager, and Mr. Richard Bechtner, Assistant Works Manager, reporting to Mr. Wm. Watson, Vice-President at Milwaukee. Mr. R. H. Closson will continue as Production Supervisor.

The accounting will be under the direction of Miss A. C. Newhall, reporting to Mr. J. A. Keogh, Comptroller.

For the Engineer's Library

CONTROL OF ELECTRIC MOTORS. By P. B. Harwood. First Edition. 390 pages, 188 illustrations, 6 by 9 in., cloth. John Wiley and Sons, Inc., New York, N. Y., 1936. Price $4.50.

This book, written by the engineering supervisor of Cutler-Hammer, Inc., Milwaukee, Wis., fulfills a distinct need for those concerned with the application of motors in industry. It is filled with practical, up-to-date data on the design, application and maintenance of electric motors and control devices. The characteristics of various types of motors are described as well as the methods by which these characteristics are used for control purposes. Problems frequently encountered, such as motor acceleration, dynamic braking, and resistor design, are discussed in detail. The material in the chapter on resistance design is especially detailed, and it is probable that this is the only book in which these data may be found. A number of the formulae and methods here explained are original. The chapter on two-motor drives gives an analysis of the problem, and presents a discussion of dynamic lowering hoists, considerable recent control data based on N.E.M.A. standards, etc.

The book should be valuable to plant engineers and maintenance men because it contains descriptions of equipment, methods of control and reasons for each in not too technical language. Part of the book relates to design methods that would be of value to application engineers and apparatus designers. There are many useful tables.

CONNECTING INDUCTION MOTORS. Third Edition. By A. M. Dudley. 464 pages, 408 illustrations, 6x9 in., cloth. McGraw-Hill Book Co., Inc., New York, N. Y., 1936. Price $3.50.

The third edition of this well known book is more than a revision. The type has been completely reset and many of the illustrations have been remade. The fundamental character of the volume, however, has not changed; the author, a designing engineer, applies his experience to the problem of operating engineers, armature winders, and repair men in the solution of practical questions arising in winding and connecting alternating current motors.

Originally, the material appeared in the Electric Journal in 1916. It was prepared as a general answer to questions which come to the Question Box Editor regarding Induction Motor Connections. This was later elaborated into a series of articles and finally it was expanded into book form.

An interesting feature of this new edition is the addition of a detailed method of calculating the performance of a motor from its dimensions and the proposed winding. A number of new features have been added which are commended to old readers of the book. Further explanation is given of the rotating magnetic field; a scheme is presented whereby the direction of rotation of a motor can be checked without actually running it. These and many other features make it a book that should be useful to practical men and students alike.

TABLES of grindabilities and analyses of many of the coals mined in the United States, Canada, and other countries are contained in a new 32-page bulletin recently released by The Babcock & Wilcox Co., 85 Liberty St., New York, N. Y. The grindabilities were determined by the A.S.T.M. Tentative Method D-409-35-T. Anyone concerned with the burning of pulverized coal should find these tables of interest.

AUTOMATIC TEMPERATURE CONTROL Co., Inc., 34 E. Logan St., Philadelphia, Pa., has recently issued its bulletin G-11 describing and showing some of the results of the ATC balancer for control of temperature, pressure and other variables.

THE LINCOLN ELECTRIC Co., Cleveland, O., has issued its welder specifications bulletin No. 316 dealing with the Lincoln Shield-Arc SAE welder. The various details of this unit, such as motor generator, excitation, motor control are described in some detail.

FAIRBANKS-MORSE Diesels is the title of a new catalog issued by Fairbanks, Morse & Co., 900 S. Wabash Ave., Chicago, describing and illustrating present engine models. The introduction traces briefly the development, explains the operation and uses of Diesels while the following pages show typical designs and installations.

LINDEWELDING PIPE LINES, a 32-page (8½x11) illustrated booklet published by The Linde Air Products Co., New York, contains a discussion of an improved welding method used in the construction of over 5000 mi. of cross-country pipe lines. Features treated are the economy and rapidity of construction by Lindewelding, joint design, quality and strength of welds and simplicity of field operations.

COMPLETE specifications and installation data on six types of pillow blocks, including a new universal-position model, are contained in the 1937 catalog just issued by Randall Graphite Products Corp., 609 W. Lake St., Chicago. Five of the bearings are of the self-alining type. Of these, the Standard and Pedestal models have single reservoirs, while the double reservoir oil return feature is offered in three models.

CHARACTERISTICS and applications of power pumps made by Fairbanks, Morse & Co., 900 S. Wabash Ave., Chicago, are discussed in Bulletin 6160. These pumps are offered in two complete lines, general service and heavy duty, the first with capacities up to 215 g.p.m. and 250 lb. pressure, the second with capacities up to 93 g.p.m. and 500 lb. pressure.

LESSONS IN ARC WELDING, published by The Lincoln Electric Co., Cleveland, Ohio, to provide arc welding operators and other interested individuals a thorough working knowledge of the practical application and use of arc welding, has been reissued in considerably enlarged form. The volume, profusely illustrated by sketches, now contains 44 lessons and approximately 130 pages. The lessons are based on the course in arc welding which has been conducted by the company in its plant Welding School for nearly 20 yr. This book begins with general fundamental suggestions and takes the student by easy stages through all the important phases of practical arc welding. "Lessons in Arc Welding" is mimeographed on pages 8 by 11 in. with simulated leather binding, flexible and durable. Price in the United States, 50 cents.

DATA BOOK No. 125 on Silverstreak silent chain drives of fractional up to 2000 hp., has just been completed by Link-Belt Co., Indianapolis. It is 8½ by 11 in. and includes engineering data; recommended drive selection; lubrication and casings; dimensions of chains and parts; list prices of chains and wheels; dimensions of wheel rims, hub sizes, bores, keys; chain adjusters; breaking pin hubs; electrical data.

BUYER'S GUIDE to Diamond Mechanical Rubber goods is the title of a new 27-page illustrated catalog just issued by the Diamond Mechanical Division of The B. F. Goodrich Co., Akron, Ohio. It contains illustrations and descriptions of over fifty mechanical rubber products and accessories, which are widely used throughout all industry, such as transmission and conveyor belting, hose and fittings, tubing, packing, cements, valves and matting, with tables listing horsepower capacity and minimum pulley diameter for belts of various sizes and plies, general data pertaining to the proper selection and installation of conveyor belting for different types of service and interesting facts about hose construction and application.

ALLIS-CHALMERS MFG. Company, Milwaukee, Wis., has released a new Bulletin 1185 on their step type Branch Feeder Voltage Regulators designated as Type BFR. It discusses in detail the operating principles and thoroughly covers the outstanding features with particular attentios to the tap changing mechanism and control circuits. It is well illustrated with photographs of the principal parts and of the auxiliary apparatus and also contains views of complete and installed units. Sketches and circuit diagrams assist in making a bulletin that gives complete engineering asd construction information.

THE FEDERAL POWER COMMISSION in its 16th annual report to Congress reports increased activity in the various functions which it has performed for 16 years and marked progress in the new activities entrusted to the Commission by Congress in the Federal Power Act of 1935. Among other things, these include the division of the country into regional districts for the voluntary interconnection of generating and transmission facilities to assure an abundant supply of electric energy throughout the United States with the utmost economy; the exercise of jurisdiction over security issues and assumption of corporate liability by utilities which are engaged in the interstate transmission and sale of electric energy and which are not regulated by a State Commission; the adoption of a uniform system of accounts prescribed for public utilities and licensees subject to the provisions of the Federal Power Act. The report is contained in a 68-page pamphlet which is on sale by the Superintendent of Documents, Washington, D. C., at 10c per copy.

BULLETIN M-361A has recently been issued by the Thwing Instrument Co., 3339 Lancaster Ave., Philadelphia, Pa., and treats in a short and easily understandable way the meaning of pH and how it is measured. The bulletin describes two models, one being a simple potentiometric circuit with quinhydrone or antimony electrodes or both, and the other is a vacuum tube type with quinhydrone, antimony or glass electrodes.

COCHRANE CORP., 17th and Allegheny Ave., Philadelphia, Pa., has recently issued its publications 2094 and 2540, the former

describing the Cochrane mechanical flow meter in detail, including its features of high operating power, means of checking the accuracy, uniformly-graduated charts, rugged construction and adaptability to varied conditions. No. 2540 is devoted to a discussion of the prevention of corrosion by complete removal of oxygen and dissolved gases from feedwater in modern steam plants.

DETERMINATION of the probable lives of various types of railroad, public utility and other physical equipment has been treated in the Iowa Engineering Experiment Station's Bulletin 125, "Statistical Analyses of Industrial Property Retirements," by Robley Winfrey, Research Engineer. The bulletin of 176 pages will be sent free of charge to all requesting it by letter to the Station at Iowa State College, Ames, Iowa.

TWO INTERESTING and valuable booklets regarding metals have recently been issued, the first by the Engineering Experiment Station, University of Illinois, Urbana, Ill., is entitled Bulletin No. 31, Correlation between Metallography and Mechanical Testing, by Herbert F. Moore. This is a reprint of the A.I.M.E. Henry M. Howe Memorial Lecture delivered by Professor Moore before the Society. It attempts to correlate the two types of testing and is a simple and logical explanation of what modern science has accomplished in the metallurgical field. The second booklet, published as Bulletin No. 27 of the Virginia Polytechnic Institute, Blacksburg, Va., is entitled The Plastic Flow of Metals by Earle B. Norris. It is closely related to the first paper and contains a great deal of test data well interpreted. Both bulletins are priced at 20 cents each with a limited number available for free distribution.

PULVERIZERS FOR FINE GRINDING is the title of a 48-page catalog just published by the Whiting Corp., Harvey, Ill. The bulletin gives constructional details, data and general specifications of Whiting impact pulverizers and by photographs shows their application to boiler and industrial furnace installations.

A TENTATIVE CODE of recommended practices for testing and measuring air flow in exhaust systems has recently been published by the American Foundrymen's Association. 222 W. Adams St., Chicago. This is an 8½ by 11 in. booklet of 13 pp. and 12 figures and is designated as Reprint 36-27. Price is $2.00 per copy. It is prepared to aid in the standardization of the general type of instruments and technique employed in determining the volume and velocity of air flow, and covers the application and testing technique for pitot tubes, inclined and vertical manometer gages, revolving vane type anemometers and swinging vane type direct reading velocity meters.

THE OSTER MFG. CO., 2057 East 61st Place, Cleveland, Ohio, has recently issued a catalog dealing with the entire line of Oster-Williams pipe and bolt threading equipment as well as welding equipment. This catalog is profusely illustrated so as to give a clear idea of the details of the construction of the company's products and contains tables of specifications of the various pieces of equipment described.

ALLIS-CHALMERS MFG. CO. of Milwaukee, Wis., has just released a new bulletin 1184 entitled Network Equipment. It offers a complete line of low voltage, alternating current network apparatus, comprising transformers of both vault and subway types, disconnecting and ground switches, and network protectors for all applications.

C. J. TAGLIABUE MFG. CO., Park & Nostrand Ave., Brooklyn, N. Y., announces the publication of a new catalog No. 699D, describing oil testing instruments. It contains listings and descriptions as well as technical information on every oil testing instrument of importance, including thermometers, hydrometers, colorimeters, viscosimeters, flash and fire test apparatus, distillation apparatus, etc. In addition, there is a complete set of charts for determining viscosity-index, comparing viscosities at various temperatures, blending and determining gravity corrections.

GAS ENGINES AND COMPRESSORS as made by Clark Brothers Co., Olean, N. Y., are described in a 17 page catalog in colors, just issued by that company. The bulletin contains photographs of typical installations, describes the units and gives performance curves.

WATER LEVEL RECORDERS of a new short term multi-scale pattern known as Model FD are described in a new four page bulletin issued by Julien P. Friez & Sons, Inc., Baltimore, Md.

INDEX OF APPLICATIONS published as Bulletin No. R-94, by the Manganese Steel Forge Co., Philadelphia, Pa., is arranged in alphabetical form by applications to show the possible use of Rol-Man True Manganese Steel. Announcement is also made that this steel is now available in a welding rod for reclaiming of worn or broken manganese steel castings or hard surfacing surfaces, and is also available as threaded bolts.

DEEPWELL TURBINE PUMPS as built by the Byron Jackson Co., Berkeley, Calif., are described and illustrated in a 40 page bulletin, No. 366. Characteristic curves and performance charts of the various types are given and in the back of the catalogs are tabulated hydraulic data and engineering information.

MODEL SA150 Lincoln Welder is described and illustrated in a folder sent out by The Lincoln Electric Co., Cleveland, Ohio.

TWO NEW BULLETINS have just been issued by the Precision Scientific Co., 1750 N. Springfield Ave., Chicago, Ill. Bulletin TS 3000, 24 pages, tells how to conduct accurate B.t.u. tests with flow type gas calorimeters. The new manual contains detailed instructions approved by the United States Bureau of Standards and also essential calorimeter tables reproduced from Bureau of Standards Circular No. 65, now out of print. Bulletin TS 3110, 8 pages, contains information and operating instructions pertaining to wet test laboratory gas meters.

PREPARED to fulfil the need for compact, ready reference on condenser, heat exchanger and sugar tubes, the Condenser Tube Manual, published by the Bridgeport Brass Co., Bridgeport, Conn., contains a great deal of data for the engineer. This is a 5½ by 8½ in., 51 page booklet giving data on various types of alloys, corrosion, specifications, weights, brass and copper pipe tables and low temperature steam tables. The manual will be mailed free to those requesting it on business stationery.

PROGRESS of the Nickel Industry in 1936 is summarized in a 35-p. review by Robert C. Stanley, president of the International Nickel Co. of Canada, Ltd., Copper Cliff, Ontario, Can. It covers fully the applications in the principal fields of industry, showing the uses of nickel steels and nickel cast irons in machinery and equipment for industrial processes.

REVIEW of the market for manufacturers in the iron and steel industry is given in a 51-p. summary and analysis with maps and tables, issued by the U. S. Department of commerce, price 10 cents.

COCHRANE Meters, their uses and performance for measuring steam or water flow are treated in an illustrated folder from Cochrane Corp., 17th and Allegheny Ave., Philadelphia, Pa.

THE RELIANCE ELECTRIC & ENGINEERING CO., 1088 Ivanhoe Road, Cleveland, Ohio, offers a folder describing the methods used in its plant for the manufacture, testing and inspection of commutators for direct current generators and motors.

MATERIALS HANDLING PUMPS, pipe line fittings and rotary dredge cutter heads as made by the American Manganese Steel Co., 389 E. 14th St., Chicago Heights, Ill., are described and illustrated in a new 20 pa. bulletin.

EDGE MOOR steam generating equipment is described in a new 20 pa. Catalog No. 102 just prepared by the Edge Moor Iron Works, Edge Moor, Del. The catalog describes various types of water tube boilers manufactured by the company and includes accessory equipment such as water walls, air preheaters and waste heat boilers. Copies will be mailed free to interested readers if the request is made on business stationery.

STANDARDS FOR 1936. Published by the American Society for Testing Materials, 260 S. Broad St., Philadelphia, Pa. Size 7 by 9 in., cloth bound. Printed in two parts, Part I 898 pages, Part II 1477 pages. Price of either part separately, $7.50; both volumes $14.00.

The book of standards is published triennially and contains all the standard specifications, methods of test, recommended practice and definitions formally adopted by the Society. Part I covers metallic materials and Part II non-metallic materials.

In each part the specifications for a particular class of material are given first, followed directly by test methods, definitions, etc. A complete subject index lists each standard under the principal subject covered with the keywords in alphabetical sequence. This index together with the two tables of contents, one listing the standards by materials covered and the other in order of sequence of the serial designations, facilitates the use of the book.

Of the 181 standards in Part I, 109 cover ferrous metals, steel, wrought iron, pig iron and iron castings and ferro-alloys. Sixty relate to non-ferrous metals, including aluminum and magnesium alloys, copper and copper alloys, lead, nickel, zinc, bearing metals, solder metals, deoxidizers, electrical-heating and electrical-resistance alloys. Twelve of the standards involve metallography and general testing methods.

Part II contains 335 standards on nonmetallic materials such as cement, refractories, coal and coke, electrical insulators, petroleum products, etc. Many new standards adopted in 1936 are included in both volumes and important revisions have been made in many of the standards.

Power Plant Construction News

Ala., Fairfield — American Steel & Wire Co., Fairfield, plans installation of electric power equipment in new addition to local mill for large increase in present capacity. Entire project will cost close to $200,000. Main offices of company are at 208 South LaSalle Street, Chicago, Ill.

Calif., Los Angeles—North American Aviation Co., Imperial Highway, Inglewood, Calif., plans installation of electric power equipment in new aircraft manufacturing plant at Los Angeles Municipal Airport, where site is being selected. Plant will total over 140,000 sq. ft. floor space. Entire project will cost over $175,000.

Calif., Los Angeles—Swift & Co., 3750 Jewel Avenue, Vernon, Los Angeles, meat packer, plans installation of electric power equipment in new four-story addition to local edible oil refining plant, address noted. Entire project will cost over $125,000. Main offices of company are at Union Stock Yards, Chicago, Ill.

Conn., Hartford—Hartford Electric Steel Co., 540 Flatbush Avenue, plans installation of electric power equipment in new one-story addition to mill, for which superstructure will begin soon. Entire project will cost in excess of $50,000.

Del., Wilmington—Mentholatum Co., Wichita, Kan., manufacturer of drug specialties, plans installation of electric power equipment in new two-story and basement plant at Fourth, Fifth and Webb Streets, Wilmington, where site has been acquired. Cost over $80,000. Local offices have been opened in Delaware Trust Building. G. A. Hyde is secretary and treasurer.

Fla., Port St. Joe—St. Joe Paper Co., recently organized, affiliated with Mead Corporation, Chillicothe, Ohio, manufacturer of paper products, plans power house at new pulp and paper mill on large tract of land at Port St. Joe. Entire Project will cost over $6,000,000. George F. Hardy, 305 Broadway, New York, N. Y., is consulting engineer.

Ga., Atlanta—Edgewood Shoe Factories, Inc., 16 Yonge Street, S.E., Candler W. Butler, in charge, plans installation of electric power equipment in new two-story plant on local site at Caroline Street and Moreland Avenue, S.E. Superstructure will begin in February. Entire project will cost close to $150,000. Robert & Co., Bona Allen Building, Atlanta, are architects and engineers.

Ind., Indianapolis—Indiana Farm Bureau Co-Operative Association, 309 West Washington Street, plans installation of power equipment in proposed oil refining plant on local site at Kentucky Avenue and Henry Street. Proposed to begin work in the spring. Entire project will cost about $150,000.

Iowa, Storm Lake—Common Council has authorized surveys and estimates of cost for new municipal electric power plant. Young & Stanley, Inc., Muscatine, Iowa, is consulting engineer, in charge.

Kan., Atchison — Missouri - Pacific Railroad Co., Missouri-Pacific Building, St. Louis, Mo., plans installation of power equipment in new engine house for inspection and repair service at Atchison. Construction will be carried out in connection with 1937 expansion and improvement program. Cost of new unit estimated in excess of $100,000.

Mass., Boston—Commonwealth Ice & Cold Storage Co., 220 Northern Avenue, has revised plans under way for new eight-story plant, 100x240 ft., for fish-freezing and cold storage, at local Fish Pier, on waterfront. Cost about $750,000, with equipment. Thomas D. Macinerney is company engineer.

Mich., Grand Rapids—Grand Rapids Varnish Corporation plans installation of electric power equipment in new two-story addition to plant, on which work is scheduled to begin in February. Entire project will cost about $65,000. Frederick A. Brown is vice-president.

Mich., Kalamazoo—Peter Eckrich & Sons, Inc., meat packer, plans installation of electric power equipment in new additions to plant at Kalamazoo, including improvements in present buildings. Entire project will cost close to $130,000. Company headquarters are at Fort Wayne, Ind.

Mich., Trenton—Dixie Oil Refining Co., recently organized, plans installation of power equipment, pumping machinery and other mechanical equipment in new oil refinery for gasoline production on local site, fronting on Detroit River. A boiler plant will be built. Entire project will cost over $500,000. Arthur G. McKee & Co., 2422 Euclid Avenue, Cleveland, Ohio, are engineers and contractors.

Minn., Crystal Lake—Common Council is arranging bond issue of $45,000, to which will be added fund from Federal grant, for new municipal electric power plant. G. M. Orr & Co., Baker Arcade Building, Minneapolis, Minn., are consulting engineers.

Minn., St. James—South Central Co-operative Electric Association, St. James, E. C. Meier, president, plans steam-electric power plant at or near St. James, for power supply for rural electrification system in Martin, Blue Earth, Cottonwood and Jackson Counties. Fund of $210,000 has been secured through Federal aid for entire project.

Mo., Kansas City — Brown-Strauss Corporation, 1446 Guinotte Avenue, plans installation of electric power equipment in connection with extensions and improvements in structural steel fabricating plant. Electric hoists and other handling facilities will be installed. A power transformer station will be built for service at plant. Entire project will cost about $75,000.

N. J., Newark—Swift & Co., Union Stock Yards, Chicago, Ill., and 154 Ninth Street, Jersey City, N. J., meat packer, plans boiler plant in connection with new edible oil refinery at Port Newark, where large tract of land has been leased from city. Electric power equipment will be installed for refinery service. Entire project will cost close to $700,000.

N. Y., Dunkirk—Van Raalte Co., Inc., plans installation of electric power equipment in new addition to local silk mill, 65x150 ft. Entire project will cost close to $100,000. Work will be placed under way soon. Main offices of company are at 295 Fifth Avenue, New York, N. Y.

N. C., Spray—Carolina Cotton & Woolen Mills, Inc., Spray, plan installation of electric power equipment in two new multi-story additions to local mills, and two-story addition to branch mill at Draper, N. C. Work will begin soon. Entire project will cost close to $300,000. Company is operated by Marshall Field & Co., Chicago, Ill.

Ohio, Cleveland—Forest City Brewery, Inc., 6900 Union Avenue, S.E., plans installation of power equipment in new addition to plant, designed to double present capacity. Entire project will cost about $125,000. R. F. Outcault, 3575 Gridley Road, is company engineer.

Ohio, Clyde—City Council has authorized call for bids for equipment for extensions and improvements in municipal electric power plant, including 750-kw. steam turbo-generator unit and accessories, condenser, cooling tower, switchboard and complete auxiliary equipment.

Ohio, New Philadelphia — Reeves Mfg. Co., Dover, Ohio, plans installation of electric power equipment in new sheet metal products manufacturing plant at New Philadelphia, comprising main unit, 50x300 ft., and number of smaller buildings. Entire project will cost close to $500,000.

Pa., New Castle — Pennsylvania Power Company, Youngstown, Ohio, has plans maturing for new steam-operated electric generating plant on site acquired at New Castle, and will begin work early in 1937. Extensions will be made in transmission lines in that area, with power substation and switching facilities. Entire project will cost close to $2,500,000.

Texas, Houston—Gulf Portland Cement Co., Trinity Life Building, Fort Worth, Texas, plans installation of electric power equipment in new cement mill on Houston ship channel, where site, 300x500 ft., has been acquired. A steam power house will be built. Work will begin early in February. Entire project will cost about $450,000. Howe & Wise, Scanlan Building, Houston, are engineers in charge of surveys.

Texas, Port Isabel—Common Council plans electric-operated pumping station on Rio Grande River in connection with new waterworks system. Entire project will cost about $72,000. Financing has been arranged through Federal aid.

Va., Alta Vista—Lane Co., manufacturer of furniture products, plans installation of electric power equipment in new addition to plant, including improvements in present mill. Entire projects will cost about $100,000. Bryan & Terhune, 2 Rector Street, New York, N. Y., are consulting engineers.

Wis., Green Bay—Green Bay Soap Co., Green Bay, E. A. Meyer, President, is planning a power plant for new soap and rendering works to be erected soon. Equipment needed includes two boilers, about 150 hp. each, stokers and generating unit.

Wis., Janesville—Rock County Electric Co-operative Association, Janesville, John Dybevok, secretary, has plans maturing for steam-operated electric power plant on local site, in connection with rural electrification project. Station will cost about $40,000, with equipment. Financing has been arranged through Federal aid. E. B. Wayts, engineer, Wisconsin Rural Electrification Authority, Capitol Building, Madison, Wis., is engineer.

Wis., Menasha — Marathon Paper Mills, Inc., plan installation of electric power equipment in new addition to paper-converting mill. Entire project will cost close to $250,000. D. C. Everest is vice-president and general manager.